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## ABSTRACT

This study identifies and assesses the potential impact of new electronic technologies on education in private homes, and looks beyond immediate incremental changes to broader, more subtle, complex, or threatening changes that may require attention from federal policymakers. Some educational implications are discussed: (1) equality of access to high quality education, including opportunity for the disadvantaged and handicapped; (2) the organization of education in society, including local school finance, private schools, alternative education, and national education resources; and (3) the Federal role, with sections discussing monitoring and research, planning and policy making, and support for capacity building. The appendices provide discussions of the in-home educational needs of poor and low motivated students and the handicapped, trends in developing and marketing new technology with in-home educational potential, and current federal activities related to in-home educational technology. (CMV)

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## EDUCATIONAL IMPLICATIONS OF IN-HOME ELECTRONIC TECHNOLOGY

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## EXECUTIVE SUMMARY

Several concurrent developments in electronic technology could result in dramatic changes in education in this country. This prediction does not assume that new electronic technology will be broadly and rapidly accepted into the public schools. Indeed, public schools may be the last to adopt the new technology. Instead, we anticipate that the great diversity and rapidly reducing prices of the new technology will cause it to be developed and used first in other settings—entertainment, industry, and particularly the private home—and that the most important effects on traditional schooling will be the indirect result of extremely potent changes elsewhere in the society.

Some of the changes wrought by the new technology will appear as general benefits to education. Parents will be able to provide intensive, individualized instruction to supplement regular school lessons. New devices will substantially reduce the isolation of many handicapped students, allowing for more "mainstreaming" and a more normal school life. Educational resource differences between urban, suburban and rural schools could be greatly reduced through electronic means rather than through massive financial redistribution.

These and other benefits could be offset, however, by other consequences of improved technology that are less desirable, or even disruptive. The most ominous predictions result from the fact that most of the advantages of the new educational technology will be acquired almost exclusively by children from middle and upper income families. Manufacturers are seeking these markets first, and will gear their devices and materials to the interests, needs and motivations of those who are most able to pay. For low income, low achieving children, the result may be a whole new set of disadvantages more severe and even more difficult to remedy than those they already face.

Widespread use of in-home technology also raises the possibility of broad changes in the institutional structure of education. When affluent parents can buy tailor-made educational packages, will they be less willing to support struggling schools with their tax dollars? Will they demand voucher systems that allow their children to attend private schools more receptive to the new learning media? Will they cease to need education as a "public good?"

Highly specialized diagnosis and testing materials are among the most likely uses to which the new technology will be turned. When these are available "over the counter," will they, in effect, create a national curriculum? If, as we expect, these diagnostic and evaluation capabilities rely on traditional and highly structured views of educational progress, how will the public react to school innovations and experiments that try to improve education through less traditional approaches?

Although a variety of Federal agencies, including some portions of HEW, are modestly involved with the new technology, the Federal policy machinery, as a whole, is not prepared to deal with either the opportunities or the crises that will very soon be upon it. Monitoring of private market developments is urgently needed during the next few crucial years. Far-sighted planning is required to see that special concerns and target groups are given the priorities they need (through both private and public investment) and that the social benefits of the new technology are distributed equitably. Strong leadership is called for to encourage the development of facilities and training of professionals directed toward subtle but urgent research needs. Finally, careful coordination is essential within and among Federal agencies as they tackle the difficult task of balancing competing demands for public attention and monies.

The new electronic technology appears to have reached and passed a "take off" point, after which its development progresses geometrically in speed, diversity and quality. Decisions are already being made about Federal tactics, but there is, as yet, no evidence of any overall strategy that could avoid the confusion, direct the benefits and mitigate the potentially divisive effects of the new technologies. It is not too soon to begin developing that strategy. In fact, it is very nearly too late.

## EDUCATIONAL IMPLICATIONS OF IN-HOME ELECTRONIC TECHNOLOGY

The new electronic computing and telecommunication technologies offer important new tools that could be of major help in resolving key national issues such as controlling educational costs and improving its quality, containing health care costs, and improving the productivity of service industries and government. These new tools are particularly interesting because they may permit society to reduce the intensity of requirements for skilled labor in some service areas, allowing us to return a large measure of self-responsibility to the personal initiative and self-determination of individual citizens. At the same time, these new technologies, accompanied by changes in the availability of knowledge and control of this knowledge, present a host of complicated issues for public policy.

The purpose of this study is to identify and assess the potential impact of these technologies on education in private homes. The assessment is intended to look beyond the incremental changes already apparent, to those broader, more subtle, complex or threatening changes that may require attention from Federal policymakers.

### The New Educational Technology

We forecast that public education could be radically altered by the new technological revolution. The importance of this revolution is still largely unrecognized by either policymakers or the general public, because it is obscured by the relatively minor impact of previous developments in educational technology. This latest revolution results from the convergence of five basic changes:

- (1) The continuing rapid development of microprocessors will permit the design and sale of instruments with several thousand times the power of today's home computers at a cost that makes them accessible to the average family within the next five to ten years.
- (2) Improved video recording disks and tapes will permit home production as well as inexpensive access to a vast range of commercial or library material on demand within the next two to four years.

- (3) Satellite transmission to very small ground stations—as small as two feet in diameter and costing between 2 and 15 thousand dollars—makes communications costs today nearly independent of distance.
- (4) Fiber optic and coaxial cable hardwired systems, which are just being built commercially today, will permit broadband electrical and light-based transmission of complex signals such as video programs between any two points, such as home-to-home, at reasonable consumer prices.
- (5) New software programs are increasingly able to incorporate sophisticated elements of "human" judgment and expertise, previously found only in highly skilled (expensive) workers and professions.

The possibilities for applications of the new technology are nearly infinite. It is not an overstatement to say that almost any conceivably useful communication or information device can be built with today's technology, and that volume production would bring the costs well within reasonable ranges.

Because "the technology" of which we speak is so complex and multifaceted, we will use the terms "in-home educational technology," "electronic media," "telecommunication and computation media," and similar terms interchangeably. We will use the term we feel is most descriptive in context because the same basic technology will serve many functions including in-home education.

#### Technology and the Schools

The new technologies offer a variety of powerful new resources to the schools. While the greatest advantages obviously come from the combination of the several technical developments previously mentioned, the advancing state-of-the-art in software is perhaps the most important aspect to this discussion.

Most of the systems with which the public is now familiar present the user/learner with programmed instruction, which is based on behavioral modification principles, or which forces the learner into a highly passive

"reader" role. Current learning theory, however, strongly suggests that strategies that promote exploration and discovery by the student are both more attractive and more beneficial to many learners. In applications of this more Piagetian approach, the instructor interrupts the student only when diagnosis indicates that the student is not learning well. When that happens, the instructor waits for a good opportunity to interrupt, then calls the student's attention to a learning opportunity, and explains the lesson in a degree of detail sufficient to the student's need.

These three tasks—diagnosis, searching for an effective instance to use as a lesson, and deciding on the level of instructional detail—require a great deal of judgment and calculation. Doing these three tasks well are the distinguishing features of good teaching. Computerized instruction of the 1960s and 1970s did not even attempt to imitate these skills. However, the new microprocessors, with their tremendous computing power and rapidly declining costs, make the use of these more sophisticated teaching strategies economically feasible.

Clearly, when the potentials of the new technologies are considered in the abstract, they should appear attractive to any society that values education as highly as does ours. In practice, however, the new technologies will have to overcome a long list of serious obstacles to their use in the traditional school system.

Past technological changes, such as television or programmed instruction, have had remarkably little impact on public education. Initial capital investments were high, and while those technologies presented information efficiently, they often amounted to little more than mechanical substitutes for workbooks. The intuition, guidance, and discretion of the teacher was still required to diagnose what materials should be used and to intervene at appropriate times with alternative ways of understanding concepts. Thus, extremely optimistic promises for uses of the technology were unfulfilled, and commercial service to education markets was reduced to relatively unexciting equipment, limited curricular repertoires, and modest sales.

For somewhat different economic and social reasons, the new technologies also may make only minor changes in the day-to-day activities conducted in schools and classrooms at the elementary and high-school levels. The fiscal crunch and declining enrollments that threaten teacher employment will limit the deployment of new technologies until their superiority on a wide range of learning functions is uncontrovertibly documented.\* Disappointment with past investments has made schools reluctant to invest further, and the social and organizational structure of schools has proven highly resistant to the replacement of teachers by technology. Moreover, the existing marketing structure for personal computers, new electronic devices, and software is optimized to sell to homes rather than to schools.

Therefore, the major impacts of the new technologies will not be in the school, but probably in the home--more specifically, in the homes of middle and upper income families. This situation is not simply a matter of costs, but rather of the additional uses to which the new technologies can be put for these families (for example, entertainment, communication, energy consumption monitoring, or tax preparation). In addition, the educational background of such family members (including experience with computers and computer languages) allows them to feel more comfortable with "high technology." Moreover, the acquisition of new technologies for specifically educational uses will undoubtedly be greatest where there simultaneously exist the highest regard for education per se, and the greatest dissatisfaction with the current educational system. Events of the past few years can leave little doubt that these conditions exist in many middle and upper income families.

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\* There will come a point where schools may adopt very rapidly the new technologies, but without national leadership this will almost certainly come after their adoption elsewhere.

The development and management of the new technologies is currently being shaped (driven) by three forces: public demand for entertainment; business demand for data processing and communications; and federal and state laws and regulations such as broadcasting zones, and consumer protection laws that stress high product accountability. At present, public sector institutions such as schools do not represent a relatively attractive market for personal computers that provide human services. Moreover, public policy and management is not strongly encouraging development and incorporation of educational and similar services into this new technology. As long as this situation exists, applications of the new technologies will respond to private markets in the order of their comparative profitability, regardless of their relative social consequence.

Paradoxically, because the "new technologies" are likely to be privately directed--toward the business and the home, their impacts are of great consequence to the makers of public policy. Specifically, the new technologies raise entirely new perspectives on equal educational opportunity, parental involvement in education, preparation for jobs and careers, and almost every familiar educational issue including support for the public school system. A few brief examples in two major issue areas may clarify both the opportunities and the threats that are posed by the new technology.

#### Equality of Access to High Quality Education

The current public education system has at least two characteristics that tend to minimize the differences in formal education among subpopulations (or, to state it positively, provide some measure of equal educational opportunity).

- (1) Teachers and schools are allotted almost the sole responsibility for formal education. Some indirect (though not unimportant) educational advantages accrue to middle upper class children through such nonschool activities as leisure reading. However, parents make relatively little real attempt to supplement formal schooling with structured education in addition to the regular school day. Thus, all children attend school for approximately the same duration, and have roughly equal exposure to those educational opportunities.

- (2) As a result of conscious public policy, the last two decades have witnessed a mild leveling of access to similar physical facilities and materials for all types of children. Inter-district financial equalization, federal and state categorical programs, and civil rights initiatives have all been factors in this process. Public policies are heavily invested in the belief that continued pursuit of these strategies will eventually result in substantially greater leveling (preferably, "leveling up") of these calculable components of educational opportunity.

However, the introduction, development, and purchase of the new technologies with primarily in-home applications could disrupt this prospect of equal education.

#### Educational Opportunity for the Disadvantaged

The new technologies are attractive as potential aids to educationally and economically disadvantaged children. The opportunities to provide such children with almost limitless amounts of teaching time in a variety of learning styles and with a vast array of highly individualized materials would seem to be the answer to an educator's prayer. Although low income/low achieving children are typically less familiar with the mechanics of educational technologies, they often respond with great interest to a learning situation over which they have some measure of control, and which never scolds or loses its patience. If the potentials of the new technologies were thoughtfully developed, they could prove extremely useful in supplementing traditional teaching to provide more equal and more appropriate education for this important group of students. There are other, more disturbing possibilities, however.

When high quality, effective education can be provided outside the school (inside the home), the trend toward educational homogeneity is replaced by a trend toward disparity. That is, the quality and diversity of "facilities" and additional time spent in formal learning is likely to be vested differentially in favor of the most advantaged groups of students. This situation, in effect, "raises the top" faster than the bottom and so recreates the very equity gaps that policy initiatives have

attempted to close. Moreover, since these investments occur in private homes rather than within the system of public schools, they are unresponsive to familiar policy tools. For example, although laws can be passed to prohibit the wealthiest school districts from further increasing their expenditures on the schools, it would be politically unfeasible to keep devices like "Speak and Spell" out of the public marketplace.

A naive policy response to this problem would be to finance the purchase of "new technology" devices to low-income families who cannot otherwise afford them. Such an approach would represent a crucial misunderstanding of the problem. Simply providing a low-income, low-motivated child with a device will be of scant help if that device is programmed according to middle-class values and specifications. For example, the currently available first wave of educational technologies, such as "Speak and Spell" or "Little Professor," assumes that the user is internally motivated or, at the very least, is subject to some effective external motivation. These motivations will be lacking in the homes of disadvantaged children. They often live in crowded, noisy, distracting households; their single parents lack the energy to assist in educational activities; siblings and peers produce pressures to discard educational activities in favor of other "more fun" activities such as passive television watching; and the target children typically have brief attention spans and prefer things with immediate, concrete applications to their lives over the acquisition of abstract concepts. It is possible to "build in" motivation through the use of well-constructed software. But when motivation is built into the new devices, it will not be in response to the extreme conditions of poor, low achieving children. Unless otherwise directed, the market forces ensure that the motivations are geared to middle-class children and, thus, may still be inappropriate and ineffective for disadvantaged children.

The very use of the new technologies themselves is likely to create a new class of educational disadvantages. Not only will "user" children have some purely educational advantages (like reading better) but they will also have acquired specific skills that open the way to a set of future jobs based on information systems and equipment. These jobs will be totally inaccessible to applicants who lack "computer literacy." The more the new systems and devices penetrate the general economy and job structure, the more pronounced this new disadvantage becomes.

Clearly, government initiatives would be required in basic research, product development, and distribution of the new technologies if the special needs and characteristics of disadvantaged children were to be met and these trends modified.

#### Opportunity for the Handicapped

Much attention currently is being paid to the vast new opportunities that the new technologies offer to handicapped people. Indeed, new devices are doing much to make "mainstream" lives a reality. However, our enthusiasm should not lead us to ignore three major problems that cloud the horizon.

First, for many of the handicapped subgroups, the research community has only very limited and spotty conceptual understanding of teaching and learning approaches that make the most appropriate use of the particular set of learning capabilities of a disabled individual. For example, research and development on substituting tactile and hearing imagery for the blind is predominantly focused on hardware and engineering advances with little research underway on its psychological impacts.

Second, even when handicapped children can make use of learning psychologies and devices developed for nonhandicapped children, highly specialized devices are often required in order to access those teaching technologies. For example, many cerebral palsy victims need special control systems to access computerbased learning because they cannot manipulate a typewriter keyboard.

Third, the content needed for handicapped learners is much broader than those to be developed for average students. For example, handicapped individuals often need to learn consciously, as adults, a vast range of social and mechanical skills needed to lead productive, independent, and safe lives that average children learn in other ways (no matter how economically disadvantaged they may be). Examples of skills common among the able-bodied for which the disabled often need special training range from operating a telephone or motor vehicle to the confidence and self-reliance needed in the workplace.

Taken together, these factors produce special problems. The disabled constitute extremely small and specialized markets that have substantially greater costs per unit in both product development and distribution. These low volumes are strong disincentives for the private sector to explore applications for the handicapped, as long as other markets (entertainment, business, middle- and upper-class education) offer high-volume opportunities.

Again, the obvious solution of using federal funds to stimulate research and development and support the purchases of devices is not without serious limitations. Many of the larger consumer electronic companies are not interested in seeking federal funds for research and development due to the regulations and subsequent management burden, and the potential infringement on more profitable proprietary activities. The few companies that do seek federal funds often find that the mandates of the Bureau of the Education for the Handicapped and the Rehabilitation Services Administration in HEW and the National Science Foundation do not cover crucial phases of product development, such as market analysis. A similar problem exists for users who are trying to obtain federal support to purchase the needed devices. Money is available, but locating its source and meeting all the organizational requirements is frustrating and often fruitless. Thus, existing federal support is having less impact in this area than even its limited funding level would suggest.

Faced with both problems in product development/distribution and ineffectual federal support, it seems unlikely that the potential of the new technologies will be brought to fruition for the disabled without changes in current policies.

#### Organization of Education in Society

The implications of the new technology are not limited to concerns for special target groups. It is not far-fetched to think that these technologies may have significant effects on the overall structure of education.

### Local School Finance

For reasons that we have suggested earlier in the paper, it seems likely that educational applications of the new technologies will reach middle- and upper-class homes at least several years before they are broadly adopted in local schools. If this situation were to occur, and if the new technologies were, indeed, educationally effective, important changes in the relationship between home and school should be expected.

Among the first anticipated educational capacities of the new technologies will be the ability to independently assess and diagnose basic skills and common school subjects. Parents will be able to identify the specific learning needs of their children much more concretely than they now can and will undoubtedly exert pressure on the public schools to attend to these deficiencies promptly and individually. This development would leave the schools in a dilemma. If they were to respond to pressures for either more intense traditional teaching (that is, using more teachers) or to the acquisition of new teaching capacities in the form of new technologies, the total cost of education in real dollars would rise. There will be little inclination to raise school revenues in a nation faced with high inflation, general distrust of public schools, and a population distribution slanted increasingly away from childbearing families and toward the elderly.

Alternatively, or perhaps subsequently, the parents of children who can afford to provide in-home supplements to deficient public education will feel less necessity to support the public schools with their own tax dollars. When they can compensate for public school deficiencies independently at low cost, they may withdraw from the time-consuming and costly challenge of trying to improve public schools.

Either way, the schools are likely to find themselves subject to increased dissatisfaction from the most vocal, most educated parents and find it difficult to respond effectively.

### Private Schools

Initially, at least, the development of educational in-home "super technologies" should not exacerbate the trend toward increased private school enrollments. The ability to privately supplement public education in the home at minimal cost should somewhat reduce the portion of the demand for private education that is dependent upon judgments of educational quality. There are some reasons to think, however, that this condition would not be a stable one.

At least some of the constraints that will delay the introduction of the new technologies to the public schools are less potent for private schools. For example, private schools are less constrained in replacing teachers with "teaching systems." Thus, we may anticipate that the new technologies will be introduced in private schools before they reach broad public school acceptance. This situation could increase interest in private schools for some parents. In general, American families prefer to invest responsibility for education in an institution rather than take that responsibility within the family, particularly in two-parent professional families. A transfer of a small proportion of students from public to private schools when there was "hard evidence" to prove the superiority of one school over another would then occur. While insignificant numerically, the transferring students could have a disproportionate effect, since they probably would be "the best" of the public school student body—particularly gifted and talented students who are increasingly ill-served by the public system.

Over time, a chain reaction could result: the private schools would continue to pull off top students, making those schools better, thereby attracting more students and thus gradually eroding the top echelons of students and of parents who support improved public education. Even under the most extreme circumstances, however, the total shift occurring for such reasons would be relatively small—perhaps 10% of the public school population.

A more potent threat is raised by the possibility that the new technologies would coincide with the introduction of some type of voucher system. If a voucher system offered the choice of "better" education (that is, private schools plus high quality technology) at no additional cost to

the family, the result could be a far more significant "bail-out" from the public schools, particularly in areas where there is substantial dissatisfaction with the schools over noninstructional issues such as desegregation. Under extreme conditions these circumstances could result in a loss of 30%-40% of the public school population. Indeed, the new technologies could provide the focal point for generating stronger public pressure to institute voucher plans. A transfer of this magnitude could produce a two-class education system that contradicts the very foundation of federal education policy. Even a marginal tendency in this direction should be regarded with substantial caution.

### Alternative Educations

As we have previously discussed, applications of the new technologies will initially be outside of the traditional public school system. This does not, however, exclude their use for more broadly defined educational purposes.

Many such uses are associated with the growing demand for Lifelong Learning, the granting of credit for nontraditional educational experiences, and the adaptation of long hallowed college and university curricula to the needs and interests of older adult learners. Declining 18 to 34-year old populations are creating strong incentives for many higher education institutions to attract and adapt to older students, while containing or reducing faculty costs. The independence and motivation of older students make the introduction of flexible new technologies a natural, if partial, solution to these institutional problems.

The new technologies also have a special part in those aspects of business and industry that rely on special training. Businesses and industry have begun to use interactive communications and teaching technologies to provide new information and skills to expensive executives who cannot be spared for traditional, time consuming and expensive graduate programs. At the other end of the spectrum, as industries assume a higher degree of responsibility for the technical training needed for entry level jobs, much of this training is done with electronic media-based instruction that reduces the hiring of professional instructors to a minimum.

### National Education Resources

The new technologies could help to provide a type of nationally shared education resource that previously has been unavailable. This potential results from two specific qualities of the new technology: its presumed national distribution, and the ability to incorporate the "teaching" as well as the "material to be taught" into the courseware. These characteristics offer the opportunity to upgrade education in areas in which the quality of educational resources, especially teachers, tends to be low. The differences in the scope and quality of available education—for example, among a large city technical high school, a high quality suburban "college prep" school, and a very small rural high school—could be radically reduced.

However, movement in this direction can be seen from a different perspective. National private distribution of standardized, high quality, high status courseware could produce the effective equivalent of a national curriculum. Under current trends, the development of this curriculum would be primarily responsive to mainstream consumers and could represent a definition of education not broadly attuned to overall societal needs. The desirability of such a consumer influence may be debated, but it is clearly an issue worthy of the attention of federal education policymakers, particularly those who are now enmeshed in the complexities of minimum competency exams.

### The Federal Role

It will be important for HEW policymakers to resist the temptation to become mesmerized by the technology itself. The potential for losing precious time and wasting resources on gadgetry of relatively minimal impact is real. By now, it is commonplace to intone that the value of any technology lies only in what we, as a society, choose to do with it, but the warning is particularly appropriate at this juncture. Left without social guidance, and particularly without adequate attention to the development of the full range of software potential, the new media could be turned largely toward uses that exacerbate rather than relieve pressing social problems of equality and equity in education. The choice facing policymakers is to get on the train now, or to be run over by it in the near future.

Of course, catching the train is easier said than done. Federal bureaucracies grind slowly. They cannot be instantly mobilized to cope with social changes as pervasive as those resulting from the electronic revolution. Nevertheless, by reviewing some of the special needs of Federal target groups, the trends and incentives of the electronics industry, and the current Federal efforts in this area,\* we can suggest some useful directions for HEW policymakers to consider.

A very useful starting point for thinking about Federal policy is to determine where present trends, if unaltered, will lead us. Our review suggests that, without intervention, the new technologies will be developed to produce educational opportunities with the following characteristics:

- o They will rely on hardware designed for entertainment and communication purposes, with little attention to determine whether other designs have greater educational value.
- o They will use courseware, the effects and quality of which are extremely varied and largely unknown. This courseware typically will be purchased on the bases of cost and very simple notions of educational needs (e.g., parents' desires for highly structured "back to basics" materials).
- o They will reflect middle- and upper-income marketplace values while neglecting the development of non-appropriable social benefits.
- o They will be distributed according to users' ability to pay, and not according to their relative educational needs.
- o They will be produced and controlled by professionals working primarily in industry.

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\* See Appendices A, B, and C, respectively.

Taken separately, some of these characteristics may not be troublesome. But collectively, they point to a clear need for social oversight. In particular, three types of federal action are required.

- (1) Broad monitoring of the capability, quality and applications of hardware and software systems based on the new electronics technology, and research to fill the gaps.
- (2) Planning sufficient to assure that potential social benefits of the technology are developed at reasonable social costs and with equitable distribution.
- (3) Capacity building to support the development of facilities and the training of professionals competent to deal with complicated new issues.

#### Monitoring and Research

In order to create the coordinating federal policy now lacking, it is necessary to know, in much greater detail than this report can supply, the pace and direction of the development of the new electronic media.

An adequate monitoring system should provide up-to-the-minute information on a wide variety of questions: What new devices or programs are being developed? What research and/or educational assumptions are they based on? How fast are the markets expanding? An adequate monitoring should also provide information of how disparate developments could be coordinated to achieve higher quality, lower cost, or greater social benefits, and what research or investment is needed to effect this coordination. No unit of HEW currently has the mandate and the resources adequate to this task.

Useful monitoring is necessarily tied to research, including both basic research and applied studies. For example, basic research may be needed to "fill the gaps" before disparate activities can be drawn together. Similarly, a form of "market research" may be needed to determine when and how to encourage private developments and direct them toward special social needs.

Hardware Support--Federal support for hardware development for education is more advanced than it is for the other areas discussed below but it is still modest and eclectic. BEH, RSA, NIE, and OE are all independently exploring new hardware from electronic controls to new satellite transmission of educational television. However, no central systematic account of these explorations is being kept. Thus the knowledge each group acquires about the desirable characteristics of in-home instructional hardware (both for the general population and for the disadvantaged and handicapped) is not being drawn together into one program for use in new product design.

This monitoring need points to associated research needs. It is not known what hardware features should be encouraged or required of manufacturers to facilitate quality in-home education. Neither is it known how industry could be encouraged or prodded to include educationally desirable features in hardware that will be primarily sold and used for its entertainment and communication functions.

Courseware Support--Federal involvement in development of high quality software that exploits the full potential of electronic technology is very limited. OE continues to support the development of high quality public television. DOD supports the development of CAI for specific high value applications in military training. Beyond this, Federal support is confined to narrow issues such as the NIE exploitation of the effects of the use of calculators on children's mathematics learning in the classroom, or the BEH effort to design a microprocessor to teach English to the deaf.

There are several serious gaps in Federal courseware efforts. There is no coordinated program of research into such topics as what to teach in the home or how. There is little support for exploring the radically new types of software that can be created now that computation is so cheap and getting cheaper. There is no program to cooperate with or stimulate business to undertake the multimillion dollar task of designing the most desirable educational software for general use in the home. Perhaps most critically there is no agreed upon set of criteria for deciding what new software is of high quality or whether its benefits outweigh its costs.

Comprehensive monitoring would not only identify these gaps, but would also identify the type of research, support or regulation needed to fill the gaps.

#### Planning and Policy Making

The conditions and needs cited above occur because the new technology has come upon us so quickly that there is as yet little national awareness of its implications and no planning for how to direct it toward the public good. In particular this technology requires planning to assure that its social benefits are developed and to assure that the benefits and costs are equitably distributed.

Social Benefits--Basic education is currently a public good in this country. The price of elementary and secondary school is nearly zero. Therefore the amount of support available to private manufacturers to develop the educational potential of this technology is lower than if all children paid directly for schooling. For reasons mentioned earlier the schools are not key markets for this technology. Moreover, problems including lack of standardization, flaws in the copyright laws, and current antitrust provisions all work to limit the private sector effort to bring out the full educational potential of the technology.

Developing the full social benefits of the new technology is also hampered by institutional separation that the technology makes obsolete. Specifically, health care, education, and welfare services have been made efficient in the past by separating them bureaucratically and physically (that is, by delivering them in schools, in clinics, and in welfare offices.) In the home, however, these functions converge. Producing maximum benefit at lowest cost to the householder will require that all three services, along with entertainment and communication, be coordinated and facilitated by the same hardware and compatible software. Only Federal planning and policy making can accomplish this.

Equity--Precisely because the new technology will allow many services that are now publicly dispensed to be had privately in the home, new forms of potential inequity will arise. Current federal policy planning focuses on using public institutions such as schools to promote equity of access to

education. Federal planning now must begin to decide how to measure inequity of access to services when they are not delivered through public institutions. For example, we must decide who to subsidize in the home and how.

This problem goes beyond issues of traditional "academic" education. If the new technology causes severe restructuring of the job market and labor displacement, the burden may be put on all of education including in-home education to create pathways to new careers. Again, it is only the Federal government that can plan for such needs effectively.

#### Support for Capacity Building

Performing research and monitoring activities such as those we have cited will require that, as a nation, we have the proper research and evaluation facilities and an adequate number of trained professionals. These same things are also needed to make the policies and carry out the programs once planned.

The nation has a short supply of at least three key types of needed staff: researchers who combine electronics and computer science with learning psychology and evaluation skills, artist-teachers who have the skills to creatively design courseware for the new media, and businessmen and policy planners who appreciate the issues and objectives of education, the new technology, and the current business and political climate. While a few schools produce such people in small number, most of our universities do not encourage such "interdisciplinary" training. Similarly we found that there are very few facilities with the equipment to do research and testing of the educational effects of the most recent technology and fewer still with any courseware design capability. Farsighted federal support is crucial to meeting these needs.

#### Conclusion

The new technologies present the federal government with a sizeable organizational and planning task. However, although a broad range of activities seems necessary, they are for the most part activities that are not particularly expensive (at least in comparison to other federal education investments). Some money is needed, but the greater needs are for

intelligence and attention. Moreover, although the tasks are complicated, actions cannot be postponed for several years of "planning the effort." Events in the private development of the new technologies are proceeding at a rate that makes such delay irresponsible. Decisions are already being made about federal investments and regulations, but they are typically made on the basis of engineering and legal perspectives. Little consideration is given to the speed of subsequent development in the new technologies, or the necessity of balancing several public needs simultaneously, especially in terms of impacts on education. The critical task of public policymakers during the next two to five years is to provide this perspective and balance.

Appendix A

THE IN-HOME EDUCATIONAL NEEDS OF  
THE POOR AND LOW MOTIVATED STUDENTS AND HANDICAPPED

## Appendix A

### THE IN-HOME EDUCATIONAL NEEDS OF THE POOR AND LOW MOTIVATED STUDENTS AND HANDICAPPED

#### Introduction

The poor and low motivated student population and the handicapped population have many similar problems. Children in both populations find few role models in the available mass media presentations in their homes. Content seldom relates to the reality of their daily lives. Expectations created by the media do not match the expectations that such children have or that their parents often have for them. As young adults, both populations face high unemployment, job discrimination, and low expectations as to the efficacy of education.

Despite these shared problems, the two populations must be considered separately. The factors that give rise to their problems differ significantly as do the strategies, services, and devices necessary to produce solutions.

#### The Use of Educational Technology by Poor and Low Motivated Students\*

During the past two decades, an enormous amount of research attention has been focused on identifying the special educational circumstances and needs of disadvantaged children. From that work, we can select particular factors that are highly likely to influence the way in which, and the extent to which, these target children interact with educational technology. For convenience, these factors have been grouped according to characteristics of the home environment and common characteristics of the children themselves.

#### The Home Environment

The home environment of poor and low motivated students are often characterized by all or most of the following situations:

- (1) One parent households: The mother, but more probably the father, is missing while the other parent is often fatigued, edgy, and lacking the energy or time to assist in educational activities or participate with the child.

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\* This section and the section on the principles for in-home educational technology systems were prepared by Drs. Gavriel Salomon and Robert D. Hess of Stanford University's School of Education.

- (2) High-density: Many of the homes in the target population are likely to be high-density homes; they are crowded and noisy, and have little space for additional equipment. Such homes are not likely to have well-differentiated areas designed for different activities, nor are they likely to have quiet corners to which a child can retreat.
- (3) Absence of time allocation: The activities of the target families are not likely to be scheduled. It is unlikely that a given time of day is deliberately and consistently set aside for educational activities. Few families have orderly schedules for after-school activities. Bedtime is often left to the discretion of the child.
- (4) Central role of television: In many homes of the target population, the television is turned on for most hours of the day and evening. Television serves as a focal point of interest, but it also serves as background noise when no member of the family watches it. Any alternative activity that may require the television for use as a CRT may make the task of motivating a child to use an educational technology particularly difficult because of competition with regular television watching.
- (5) Siblings: Many siblings in a relatively crowded space may provoke conflicts with the target-child who wants to use the educational technology. On the other hand, siblings might be used as part of a supporting social group to share the "play" features of the technology if it is designed for interactive play as are many games.
- (6) Discretionary income: Many of the target families are likely to have limited income and thus are not likely to invest the little extra money they may have in educational technology.
- (7) Importance attributed to learning: While education and learning are often perceived as important, they may not be perceived as important enough to warrant setting aside special funds, time, parental attention, and space to accommodate learning activities of one of the children. Learning by means of some technology is likely to be given low priority particularly when it threatens to interfere with routine life or make special demands on income, space, or time.

#### Personal Characteristics of the Poor and Low Motivated Student

Poor and low motivated students share many or most of the following ten characteristics:

- (1) Motivation for study: Motivation for study and for self-directed intellectual work is likely to be poorly developed.
- (2) Expectations of success: Many of the target children, even the younger ones, have had experiences that contradict the notion that there is a predictable order in the rewards and successes that they encounter. Contingency between invested effort (particularly intellectual effort) and success is often not expected.

Activities that resemble those required in school are often not expected to yield success. This situation is a reflection of the social and economic circumstances in which many low socio-economic status children live.

- (3) Status of schoolwork: The status and esteem associated with schoolwork (or similarly appearing activities) is usually not high in the eyes of the target children. Status often decreases further with age. Status of school, or school-like activities, can be expected to be somewhat higher in the eyes of preschoolers.
- (4) Peer group influence: The peer group is probably the most powerful motivator in the lives of the target children, particularly for boys and for older children and somewhat less for preschoolers. Activities defined by the peer group as high status, or at least as socially acceptable, have a better chance of being carried out. It can be expected that a child's peer group will reward him or her for other than learning activities.
- (5) Attention span: Attention span for study activities is likely to be short. Children, particularly the younger ones, are easily distracted by other activities, background noise, and similar disturbances.
- (6) Heavy television consumption: Children of the target population are known to be heavy television viewers. Television viewing competes with homework, with family interactions, and similar activities. Competition from television programs with exciting themes is likely to be especially keen.
- (7) Reading skills: Level of reading skills is low for the target children (hence, adding to the nonrewarding experience of school), particularly for first and second graders. The low reading level sets limits on the kinds of learning materials and instructions that can be planned for successful in-home uses of educational technologies.
- (8) Preference for the concrete and tangible: The target children are likely to be more responsive to concrete ideas and materials than to abstract concepts and processes. They also are likely to be more responsive to materials that appear as having practical utility and that provide immediate feedback and tangible rewards. A history of learning and environmental circumstances has often left children with a lack of confidence in long-term outcomes and vague, abstract rewards. On the other hand, these children have a strong need for observable accomplishments and feelings of efficacy.
- (9) The need for enjoyment: Because of the preceeding factors, poor and low motivated children can be expected to perform better, attend longer, and learn more when activities entail a central component of fun and enjoyment to a greater degree than the average child would need.
- (10) Perception of task: Much of the success of an educational in-home technology for any child or adult depends on the way he or she perceives it. Success in encouraging usage is less likely

when the activities with the in-home technology are perceived as extensions of schoolwork, or require a child to study alone as he or she does with schoolwork.

### Educational Needs of the Handicapped

Nearly 10% of the U.S. population have some disability that would qualify them to be categorized as handicapped, but the types of handicap vary widely. The Bureau of Education for the Handicapped estimates of the percent of the population who are handicapped\* appear in Table A-1.

Table A-1

#### FEDERAL ESTIMATES OF HANDICAPPED IN THE U.S. POPULATION

| <u>Handicap</u>                | <u>Percent in<br/>U.S. Population</u> |
|--------------------------------|---------------------------------------|
| Speech impaired                | 3.5                                   |
| Mentally retarded              | 2.3                                   |
| Emotionally disturbed          | 2.0                                   |
| Learning disabled              | 1.0                                   |
| Hearing impaired               | 0.6                                   |
| Totally and congenitally deaf  | 0.1                                   |
| Orthopedic and health impaired | 0.5                                   |
| Visually impaired              | 0.1                                   |
| Multihandicapped               | 0.06                                  |

Even these eight categories drastically oversimplify the diversity of this population. Each of these conditions ranges from moderate to severe. In some cases, the problem is congenital; in others, it results from accident, disease, or increasing old age. This diversity means the affected individuals have very different experience bases. The members of each group extend throughout the age range.

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\* Rothenberger, D., Education of the Handicapped Child: Status, Trends, and Issues Related to Electronic Delivery, Center for Development Technology, Washington University Memorandum No. 73/4, December 1973.

## The Home Environment of Handicapped Students

Just as handicapping conditions vary widely, so do the lives and home environments of handicapped individuals. Nevertheless, some generalizations are useful, particularly about the homes and families of handicapped children. Characteristics typical to handicapped children can be grouped according to the following nine topics:

- (1) Availability of the parents or other adults in the home: Significant added strain is placed on the time and energy of both parents. This strain frequently breaks marriages. Severe handicaps often require that a nurse or therapist come into the home or that the disabled person be brought to a therapy location. A significant number of parents perceive a social stigma attached to themselves and try to ignore or minimize recognizing the handicapped child's problem. Some parents feel alone and isolated and do not know how to meet other parents with similar problems. Other parents assume responsibility and spend the often large amounts of time necessary to obtain the training (e.g., as a physical therapist, educational trainer, or acquire sign language) to care for their child. Some parents over react and smother or over protect their disabled child preventing development of whatever independence and capability he or she potentially has.
- (2) Density of living space: The homes of disabled children run the full range available to the general public. However, many families with a disabled child need special features such as ramps, ranch style homes, lights to replace bells and buzzers, or various automatic control devices. Some must set aside a large amount of space for special equipment. Some disabilities such as blindness require that the disabled person have a carefully ordered physical environment and that others not rearrange that environment.
- (3) Type and degree of routine: The lives of most disabled persons require a significantly higher degree of routine than do the able-bodied. The mentally and emotionally handicapped often need more routine to give them a sense of stability and predictability. All disabled persons, but especially the sensory and orthopedically handicapped, rely more heavily on other people and on public services (especially transportation), all of which require more schedule consciousness and coordination.
- (4) Competing activities: The principle competing activity for many disabled people is the time consumed in dealing with the disabling condition. This scheduling includes therapy time, consultation time, and similar activities. However, an equal, if not greater, time consumer is the added burden to do everyday activities such as dressing, eating, and getting from one location to another. In some instances, there is severe debate over whether a time burden should arbitrarily be imposed. For example, in the deaf community, there is some debate over whether the tremendous amount of time necessary to teach a congenitally deaf child how to talk is justified or whether that time would be better spent

at other childhood learning and play experiences especially given the limited degree of success typically achieved in making a deaf child "oral." In the future, a similar question may arise about teaching braille reading to the blind as talking opticons become common and inexpensive.

- (5) The role of sibling and peers: While several disabled children in the same family may offer support to one another, there is often some tension and resentment between able-bodied siblings and a disabled child. Access to able-bodied age peers is often limited while contact with other disabled persons is often much higher than average. Total interaction with peers and siblings is typically below average for the population.
- (6) Monetary and material resources: Disabilities are expensive, even with the amount of subsidy available through public agencies to meet various costs. This situation places an added burden on the family in terms of additional costs for transportation, housing, and basic supplies (even special food). The time and effort that a parent or disabled person must invest to obtain what assistance is available from the many varied and uncoordinated federal, state, local, and private support agencies is also very large.
- (7) Socio-cultural role models: Until most recently, all (and today still most) disabled people are taught indirectly to be dependent on others even when this dependence is unnecessary. The legal system for allocating support to the disabled still contains disincentives and outright penalties for many disabled people to care for themselves and to take responsible employment. The mass media contains few if any role models for many of the handicapped. Many parents are embarrassed or overly protective of their disabled child and fail to provide social contact and information to give the disabled child access to mainstream life and culture.  
  
These problems may decrease as the new technology makes it possible for the disabled to perform more jobs and for jobs to be adjusted for the disabled.
- (8) Child's family role: The disabled child is likely to be more central in the family regardless of whether the attitude of the family is positive or negative toward the child.
- (9) Deinstitutionalization: For many of the reasons identified above the family may choose to institutionalize the child. Such institutionalization is typically paid for by public agencies and may relieve much family strain. While new technology will not likely diminish institutionalization for children put away to relieve stress or embarrassment to the parent, it may make it possible for families who would otherwise prefer to keep the child in the home to do so.

### Personal Characteristics of the Handicapped

The reader should understand that the range of personalities of handicapped individuals is as wide as that of the general population. Nevertheless, the results (and sometimes even the causes) of handicapped conditions do make some attitudes and perceptions very likely.

- (1) Motivation to study: While some disabled people recognize study as a "way out," a path to independence and success, most disabled children have lower motivation because they have experienced failure, because no clear path to the mainstream and independence has been shown to them, or because their parents or guardians have taught them to remain dependent.
- (2) Expectation of success: For many of the mentally and emotionally handicapped, there is little expectation of success often because they have only a most basic concept of success. For many other handicaps, the expectation of success is limited by previous frustration on the one hand and preclusion from attempting on the other.
- (3) Concept of schoolwork: For the mild educationally handicapped, school is often associated with feelings of frustration and some inadequacy. The mentally retarded and severely emotionally disturbed often don't relate to school or have a concept of school work that is similar to the concept held by the typical able-bodied child. The orthopedically or sensory handicapped child typically has a more normal concept of school, although the link between school and career or their future life is often less clear than for the able-bodied average child.
- (4) Type and degree of interaction with peer group: The handicapped typically have less interaction with able-bodied peers than those peers have among themselves. The handicapped often have more interaction with other handicapped peers than average. Some handicapped are physically precluded from much interaction with peers, others are segregated from peers by their parents or other institutions.
- (5) Attention span: The attention span of many orthopedically or sensory handicapped does not differ significantly from that of the general population. Mental, emotional, and educational handicaps do affect attention span, often diminishing it. Some handicaps may appear to affect attention span but, in fact, do not. (For example, many totally deaf people are not very fluent in English and have apparent difficulty in "attending to written material").
- (6) Media experience and orientation: Most handicapped individuals have an orientation to the media similar to that of the able-bodied. The less mobile and home bound may often be more heavy users of television and radio.

For the visually and hearing impaired, this area is of greatest concern. The blind are excluded from the normal printed page without a technological aid, a person to read to them, or a braille translation.

However, the most severely "handicapping" condition from the standpoint of communication and education of otherwise mentally healthy individuals is complete congenital deafness. The reason for this is that such deaf people often do not have English as their first language. They "speak" American sign language or other sign language. This lack of facility with English inhibits their use of captions on television, their use of teletype terminal and similar devices. In a new technological age, this situation limits their ability to quickly and clearly initiate messages that can be electronically transmitted. (For this reason, many deaf people would prefer video-telephone to teletype.)

- (7) Reading skills: The reading skills of most handicapped individuals are below average with the exception of some orthopedically handicapped or those whose handicap has occurred after their reading skills have developed. For many deaf, reading skills are poor or limited by their familiarity with English.
- (8) Concept of reward: For most classes of handicapped, the concept of reward differs to some extent from that of the able-bodied or other classes of handicapped. The difference is a function of the handicapping condition. However, for most handicapped an immediate reward is more effective because they have less confidence in their own ability to act efficaciously and independently.
- (9) Need for enjoyment: Because many handicapped have less confidence in their ability to obtain future rewards and opportunities through study, it is important to rely heavily on a central component of fun and enjoyment as an intrinsic reward for better performance, longer attention, and increased learning.
- (10) Perception of task: Much of the success of an educational in-home technology for any child or adult depends on the way they perceive it. Especially for the orthopedically and sensory handicapped, success is more likely when the active is perceived as contributing to their ability to become independent, or as contributing to a desirable and real future career option. For the mentally and emotionally handicapped, perception of task is highly case and condition specific and requires a great deal of individualized diagnosis and prescription.

#### Principles of Design for In-Home Educational Technology Systems

The principles enumerated in the following subsections are those currently thought to create the most attractive and potentially effective learning environments. Where special or adjustment to the specific circumstances of poor and low motivated students or handicapped, is required, this is noted. The lower the quality of an educational package as measured against the following criteria, the more likely it is to widen the education gap between advantaged and disadvantaged, or able-bodied and handicapped children.

### Principles for the Desired Learning Process

The following educational principles should be encouraged in the learning process for the handicapped and low motivated student.

- (1) Active rather than passive learning: Devices and materials that allow the child to interact with by answering questions, solving problems, or working with a partner are better than those that leave the learner a passive recipient. This is crucial not only for maintaining attention and learning but also for combating television competition. Interaction with the material should generate new choice points for the learner, which in turn require gathering and applying information (already acquired, supplied by other partner, or to be acquired from present material). For the orthopedically or sensory handicapped, special control and access devices may be necessary as the degree of sophistication in interaction increases.
- (2) Manipulation of the content: Devices and programs should allow the child to manipulate the materials; to generate new questions, new graphics, or pictorial designs; to manipulate shapes or textures; or to change the pace of presentation. Real control over the material is an extremely important ingredient in providing intrinsic motivation. For example, the younger child should be able to "draw" a label, rotate, and combine a graphic presentation on a CRT. The older child should be able to control zoom-in and zoom-out on particular parts of a display and create new displays or assemble displays by giving specific simple commands. Initial instructions on how to use the apparatus should be provided in a way that allows the child to learn the operations while actually carrying them out.  
  
Provision should also be made for the parent to manipulate the material to help diagnose and prescribe lessons and to permit exercise of parental discretion.
- (3) Supports interaction with others: Material and apparatus should enable active and interactive participation of more than one person, thus allowing possible involvement of parents, siblings, or peers. The social interaction afforded by the software and hardware is at least as important as the operation of the game or apparatus.
- (4) Speedy feedback: Material that should react immediately to a child's input, and should provide immediate knowledge of results. Instructions that a child gives should not only be spoken back to him or flashed on a CRT but also should show if and where errors were committed. For example, feedback of the kind "that is wrong, try again" should be used less frequently than "that's wrong, change the W into a V."
- (5) Optimization of learning rate: The material should allow step-wise progression. When a child's errors exceed a certain number, an alternative approach or pace should be given so that success is maximized. At crucial points, examples modeling the desired

responses should be provided. Thus, the right word, correct solution, or proper "mode of attack" (in a game) should be provided allowing the child to either copy it, or to complete it.

- (6) Maximizing success: The presentation process should react to the child's comprehension rate. It is crucial that the materials provide the child with a sense of progress, accomplishment, and success. Success requires that the material is easy enough and graduated in terms of difficulty.

However, maximizing success should not be translated into repetitions of activities already mastered. New tasks or problems need to be constantly introduced.

Success rates need to be different for different children. Some need a very high success rate to stay interested, while others need a high error rate to show that learning is needed and can take place.

- (7) Rewards: The whole experience should be highly rewarding.

Intrinsic rewards depend on enjoying of manipulation. A technology that allows the child to create a display that then unfolds in front of his or her eyes provides more enjoyment (and more extrinsic motivation) than a technology that demands of the child only to identify or recognize a pattern. Similarly, a program to figure out a particular phone number and then obtain through the phone a new program would be a stronger extrinsic motivator than having all programs available from the outset.

A strong intrinsic motivator is the child's a priori knowledge of the kinds of things he or she will be able to do at the not-so-far end of the program.

#### Principles of Content Selection and Content Structuring

The principles of content selection and structuring include the following four items:

- (1) Educational relevance and utility: Content areas of the software should be related to school activities without being explicitly school-like in appearance.

The material cannot be "didactic" because negative reactions to school can be transferred to the in-house technology. Thus, spelling, mathematics, reading, and similar subjects, which are directed at younger children, should be indirectly learned as part of a game or fun problem solving activity. (For example, spelling is exercised when the child types in commands to alter a display; mathematics is exercised when during a game with a partner certain computations need to be made to generate a move).

Older children can be taught more directly, although exercising and drill practices should be part of games and fun problem solving and not direct tutorials. Material for older children also needs to stress immediate visible utility. For example, automechanics, telephone operation, or simple computer

programming would be suitable contents. For example, a program may teach the youngster how specific autoparts operate by allowing him or her to eliminate from a model certain parts and observe a display of the consequences. Subsequently, he or she can compete with peers or siblings in a game in which engine malfunctions are to be identified.

- (2) The play value of the material: Toys we use without rules but according to their structure and capabilities. Games are played according to a given set of rules. In-home technology should combine the playfulness of toys and the structure of games. Those devices and programs that best serve the purposes of target groups may be neither an in-house technology for programmed instruction nor an opportunity for drill and practice of school-like activities. The play value needs to be retained by entertaining contents.
- (3) Pictorial emphasis: To compete with the dominance of television and to avoid trying to build on deficiencies, the material presented on any display device needs to be mainly pictorial rather than printed language. Moreover, the pictures need to provide movement and allow manipulations and transformations. Today's machines are accessible only through a basic alphanumeric keyboard or other manipulable control and not through voice commands. Therefore, their accessibility to most people, especially handicapped and poor and low motivated students (particularly, children in these groups) is severely limited. The voice to machine coding devices of the near future will revolutionize this interface and make computers dramatically more accessible to all of us. In the mean time, "joy sticks" displays sensitive to touch or to light pencils and similar response will augment significantly the simple alphanumeric keyboard.
- (4) Immediate demonstrated applicability: Newly acquired knowledge should be immediately applied in explicitly demonstrable ways. A child performing an activity with the in-home technology should be able to show to other people important in his life (parents, siblings, peers) that he has acquired something new that, in turn, will win their approval. This situation has the potential of involving an otherwise busy parent in the activity and, for older children, win badly needed peer approval.

#### Relation to Other Activities and Educational Agents

Performance characteristics of the in-home technology are necessary but not sufficient conditions for sustained benefits from the technology. It is also important that the technologies be obviously related to other activities and agents that may provide the extrinsic rewards children need.

- (1) Relation to schools. The material should not be school-like. However, encouragement to continue operating the technology needs to come from school teachers, particularly with respect to younger children. Encouragement can be given in the following ways:

- o Teachers demonstrate acquaintance with the technology and the materials and provide ongoing encouragement of children to play with it. More importantly, teachers can make the in-home technology a topic of discussion in the classroom and socially praise children's achievements.
  - o The technology is available in classrooms where children could actually demonstrate their achievements and play with it in groups.
  - o Teachers disseminate (or even prepare) new materials. These materials are then to be handed out to children as awards for their performance with the in-home technology.
- (2) Link with out-of-school agents. The organization disseminating technology to homes can also provide awards such as new fund programs to youngsters who successfully advance through their programs. This procedure suggests that some (but not all) new programs are free of charge but contingent upon success. Close contact between the dissemination agency and the youngsters needs to be established.
  - (3) Involvement of parents. The participation and encouragement of parents may need special effort even when the technology is in the home. Furthermore, one of the technology's important contributions can be in encouraging more parent-child interaction. To achieve this interaction, paraprofessionals may have to visit the home of younger children, show parent and child how to operate the technology, and generally encourage parents to engage in this activity. This could be a privately sponsored activity as is in-home encyclopedia sales today.
  - (4) Linkage to future careers, employees, and adult support systems. Probably the single most important motivator that this new media could have for the poor, low motivated young person is a strong demonstrable link between the content and real attractive job opportunities.

#### Analysis of Two Current Examples of Educational Technology

The criteria discussed in the preceding sections provide the means for assessing specific technological developments. As examples of how they may be used, we assessed two devices currently on the market and designed for home use.

The first example is the teaching-calculator "Little Professor." The calculator provides increasingly more difficult arithmetic exercises. The child can respond to the exercises but not interact with them. Every step is prescribed. There is also no room for manipulation because no provision for a child's input other than "the answer" is incorporated. Learning is direct rather than indirect and very mechanic, bordering on rote repetition. There is no opportunity for interaction with other players, but a player receives feedback of the "right/wrong" type. It is not an informative type of feedback. The exercises, while ranked in difficulty, are not designed to optimize learning, although they could be so designed. Maximum

success is not assured; the program moves on to new exercises whether the child responds correctly or not. No rewards are given to the child in any form except this toy's limited play value. All the material is of one kind only (math exercises). While many of the exercises are relatively easy, they are "sterile" and school-like. Clearly, there is no way to link the use of the calculator to any school or home activity. At best, a strongly motivated child could test his or her math skills alone until the range of ready-made exercises are exhausted.

The "Video-Brain" home computer, employing a teletype and CRT, allows a much wider range of materials by using cassettes and displays. This computer allows interaction and a measure of manipulation (at least by providing choices). Some of its materials invite direct learning in a programmed fashion, for example, mathematics; others are more entertaining but have little direct or indirect learning value. (However, this is a limitation of the software not the hardware and could be overcome.) Such a technology can be converted to meet our recommendations (the home computer sold by Radio Shack allows simple programming by the user), but needs first to be greatly simplified.

#### Gaps in the Characteristics of Available Technology to Provide Teaching in the Home

The process of teaching, as contrasted with the process of learning, involves three basic tasks:

- (1) Diagnosing the learning behavior of the student and prescribing a learning opportunity or setting.
- (2) Deciding when to provide coaching and with what degree of detail (for example, simply suggest the student look for another strategy, give a clue, explain an alternative, or provide an example for the student to model).
- (3) Delivering articulate expertise once the coaching decision has been made (for example, having a good set of clear examples and explanations at hand when needed).

Education in the home today must take place largely without the help of the three teaching processes. Parents often lack the time to spend coaching, and many lack the expertise to do high quality diagnosis or to offer clear, articulate expertise. Books, recordings, and television often contain the expertise but lack an active agent other than the student himself to diagnose what expertise is needed in a specific instance. Moreover, such media are passive and lack the ability to adjust their degree of coaching to the learner's specific immediate need.

Programmed instruction in book or machine form is little better. To incorporate some of the teaching tasks programmed instruction requires the student to use a very stilted and lock step (though multiple path) learning process.

The media that presently exists does not teach.

The new media, however, need not have this limitation. Because microprocessors can "process" information cheaply, the new media can bring the three teaching functions into the home to augment the capabilities of today's media in presenting information. This development will reach the home when two conditions are met:

- (1) The cost of computing power declines enough to put the equivalent of today's five hundred thousand or one million dollar computer in the home for under \$1,000 (in 1978 dollars).
- (2) When a backlog of proven teaching software has been developed.

The first of these will happen automatically within the next decade. The second will happen only with major backing from the educational community (for example, government, foundations, schools, and parents concerned with education).

The software need is very great and will be expensive and complicated to create because the teaching functions it must incorporate are very complex. An elementary school math series, for example, will be at least several times as expensive as was the "new math" program. Only a very small amount of "teaching" software exists today. In contrast we have today a large backlog of "learning" software. Programmed material, for example, is learning software with a little teaching software built in. Teaching software monitors a student's actions in dealing with a learning situation and analyzes the student behavior against criteria for good learning strategies, thus learning well, no action is needed by the machine. When the student is having difficulty or calls for help, the teaching software must be ready to select among alternative coaching strategies. Part of this choice should depend on the program memory as to which strategies helped the student most effectively in the past. Finally teaching software has an array of well constructed expert advice, models, and examples to use in doing its coaching.

In the disk-based book available ten years from now, we can expect to find the content equivalent to a semester length course in an academic subject, for example, geography. However, this content will only fill a tenth of the disk. Today, disks can hold 154,000 "pages" of material where a page is equivalent to a television screen. This disk is the learning software. The other nine-tenths of the disk will be loaded with the teaching software to diagnose, coach, and provide expert advice.

#### A Note on Distribution and Acceptance

Even when the necessary price adjustments have been made, and the required software produced, there will be special problems associated with the marketing and distribution of educational technologies to special populations. Serving the handicapped will be particularly difficult, as they have relatively few problems and needs in common with large market groups.

Three strategies exist to serve this population. The first is to set up small, focal programs to deal with the unique situation faced by special populations that are often as small as a few hundred or thousand and scattered across the county. From a private business perspective, this strategy is typically not economically viable, let alone attractive.

The second is to aggregate this population on a worldwide scale, but this strategy is as yet politically only partially feasible.

The third strategy is to find other segments of the general population that share a need with such special groups. For example, the deaf need a simple portable communication terminal to give them access to telephone service. A much larger segment of the general population wants the same basic device but for use as a terminal. A similar synthesis of needs between each special handicapped group and some much larger general population need can often be identified. However, both the handicapped groups and the corresponding general population are typically unaware of each other at best, or hostile at worst. After years of disenfranchisement from telephone communication, for example, many members of the deaf community, having finally obtained a Baudot Code-based phone system, are fearful and skeptical at suggestions that they give up that system in favor of a promised better system based on ASCII code.

Other obstacles to distribution are sociological in nature. The development of a technically sophisticated educational resource for home-based learning does not automatically ensure a high level of utilization by families for whom it is designed. The target families for this equipment have had their educational experience and opportunity limited by poverty or discrimination, or both. No single piece of apparatus, no matter how carefully designed, can balance the long-term effects of social and educational inequities. Families are social and affective minicultures that establish their own norms, and priorities as to how time and energy are to be spent and how the resources of the home will be used. A new piece of equipment is thus introduced into an ongoing system; its acceptance and effectiveness can probably not be ensured by its design properties or prepared programs.

The family is also part of a wider social network that has its own patterns of interaction, values, and attitudes. Whether a family accepts and uses the types of educational technology considered in this report may depend on the response of neighbors and institutions of the community, especially the school and the church. Parents, particularly of poorer and low motivated students, may expect that the teacher and school should carry the responsibility for instruction and that it is not the duty of the parents to take on the school's tasks. Families and their individual members are also responsive to the groups in which they participate: the social group may decide whether it is acceptable to spend out-of-school time interacting with an educational machine. Community attitudes may, of course, also support the use of such technology. Our point is that the social context may play the decisive role in the use and effectiveness of the materials offered to the family.

Appendix B

TRENDS IN DEVELOPMENT AND MARKETING NEW  
TECHNOLOGY WITH IN-HOME EDUCATIONAL POTENTIAL

## Appendix B

### TRENDS IN DEVELOPMENT AND MARKETING NEW TECHNOLOGY WITH IN-HOME EDUCATIONAL POTENTIAL

This appendix is composed of four sections. The first section presents the principle characteristics of firms making products in this area and the characteristics of the environment these firms are taking into consideration in developing and marketing new products. The second section describes the characteristics of the new technology; the third, business development and marketing trends in four key areas. The fourth section summarizes gaps in these trends relative to educational needs summarized at the end of Appendix A. The bibliography cites the primary business, service organizations and literature used to prepare this appendix.

Preparation of this appendix relied heavily on the industry expertise of SRI's Consumer Electronics Industries group and on proprietary data they have collected in the course of projects for many hardware, software, and applications-oriented media firms. In addition, the project staff conducted some face-to-face interviews with businesses and service organizations. A list of these firms is included in the bibliography to this appendix.

#### Characteristics of the Firms

##### Structure

The "industry" involved in developing the new media for providing in-home educational technology is very complex and heterogeneous. Firms can be classified in terms of three basic functions: hardware production, software production, and distribution and service. Many firms have more than one of these functions or are part of a conglomerate with more than one function. Hardware firms involved in this industry range from integrated circuit manufacturers to satellite owner operators, and to the phone system. Some manufacturers integrate all steps from component production to retailing but most are involved only in some set of substages. Software, with the exception of network television and simple logic games, is typically produced by a different set of firms including publishing houses, film producers, independent producers, and hobbyists. A third class of firms specializes in providing access to the new technology and its services. Such firms include the phone company, cable television systems, subscription broadcasters, new technology retailers, rental systems, and some library loan programs. The degree of experience among firms in this industry with regard to in-home education is very limited. What experience there is among the major suppliers is oriented toward the schools. The principle exceptions to this situation are the book publishers and the educational game producers. How to design systems using the new technology to effectively teach in the home is basically unknown among any of these firms.

This industry is under a severe and chronic shortage of key types of professional staff. Electronic engineers are in very short supply. Professionals combining knowledge of the media and of human psychology or learning theory are in even shorter supply. Individuals with the management skills and interest to combine new media with educational needs to penetrate home markets on a large scale are virtually nonexistent.

### Markets

There is universal agreement in this industry that the in-home education market ought to be very large and eventually very lucrative. However, it is currently seen as diverse and not well-defined. The driving force in the home electronics market today is entertainment, with lip service to other home uses and modest emphasis on such items as security and home retailing.

The middle- and upper-class households are seen to have the money, the market size, and the market infrastructure to buy the new electronic products that will come out during the coming decade of product development. Manufacturers will seek them as the first market and design the products to their demands. Poor and low motivated students' households are seen as a large market but lacking the resources and interest to buy educational technology and services. The handicapped are seen as a very small special market relative to other consumers of the same basic technology.

The schools are seen as a distinct market with little or no coordinating mechanism between schools and in-home educational technology. Some schools might be used as distribution systems for technology through lending libraries as some do now with recordings and filmstrips. However, in general, the schools are not seen as a major market or even as a key test market for new in-home technology devices.

Business applications for this technology are also seen as quite distinct from the home market, at least through the next decade, although there may be a gradual increase in work-in-the-home. Most certainly, there will be new business opportunities for applications such as retailing in the home through telecommunications.

Overall, there is serious question in industry about what consumers' specific interests actually are, especially in the education area. Several respondents commented to us that the features of a product, particularly a small independent item such as "Speak and Spell" that attracts a parent or grandparent to buy the product, may not be the same features as those that encourage a child to continue playing with it, and none may be the feature which contributes to "learning."

There is also substantial interest in foreign markets. While the United States and Japan are the leading producing countries for this new technology, the United States alone is still the major consumer. However, for specialty services in the interests of the general public and in service to handicapped, the Europeans, we were told, are in the lead. Sweden, Denmark, West Germany, and Great Britain were each cited as significantly

more progressive in getting this new technology into the hands of the poor and disabled. American marketers of handicapped devices, in particular, find these nations attractive buyers and much easier to sell to.

Overall, however, the education market internationally is very small, and the concerns for nationalist control of media and media content, educational curricula and similar materials may limit any rapid expansion in the near term.

### Standardization

Because of the high rate of change in the basic technology, industry faces three specific standardization issues.

- (1) Each manufacturer must decide how to ensure continuity between generations of equipment so that new cartridges of software and new peripheral equipment are compatible with both newer and older basic systems. This feature is necessary both to ensure consumers that a purchase made today will not soon be obsolete, and to build a large enough market base of equipment in use in homes to support new software development.
- (2) Another standardization issue concerns producers. Broader industry standards for hardware and software interfaces must be set either by mutual agreement or by following the market leaders. The primary purpose of such coordination would be to allow construction of special purpose small volume systems from large volume components that can be produced inexpensively.
- (3) Software programming and logic standards must be chosen to permit flexible use of the hardware, particularly in the effort to move toward machines that can be programmed using everyday English or other human language. The problem is not merely one of choosing a standard such as the selection of ASCII as a standard code or the development of ALGOL as a basic standard programming language. Rather, the issue is similar to that of developing an international human language. That is, what portion of meaning should be built into the grammar or logic of the system, and what portion of the meaning should be assigned to the words used in the grammar. This complex issue should not be arbitrarily resolved until the relative capabilities and costs of alternative hardware systems stabilize and until software production becomes a mature art. Optimistic estimates put this 25 years away, while according to more conservative estimates development will take considerably longer.

### Limits

The universal perspective of our respondents is that the only limitations to having any conceivably useful information system in the next 20 years are outside the area of hardware. Hardware costs will continue to drop precipitously; computing, recording, and transmission capabilities will continue to grow rapidly. However, the limits these firms see to development and widespread use of any desirable device are fourfold:

- (1) Our collective national ability to imagine what application would be useful and of real marketable value and to mount a focused effort to produce it.
- (2) Our ability to learn how to create software content for and to use these new tools.
- (3) The ability of the consumer, the worker, and the social infrastructure to absorb the changes this technology will permit or force upon us.
- (4) The ability of our government to adjust laws and regulations appropriately and quickly to let the technological potential be deployed.

At a somewhat lower level of generalization, the industry encounters different limitations. For example, there is no infrastructure analogous to the publishing industry or the professions of journalism and education to encourage production of massive amounts of new and often experimental programming or software for new systems. This situation exists because the technology is so new; because we have little knowledge of how to produce such material and little capacity in universities to teach what we do know, and because universities discourage graduate students from combining fields such as computer science or electronic engineering with education or human psychology. However, the most strongly stated reason for this situation is that the kind of programming needed has never existed before and may require a very different new approach to production that initially will be expensive.

The limits of which the industry is most wary, however, are those imposed by regulations. Currently, these regulations, while decreasing in their restrictiveness, directly prevent the formation of conglomerates, the natural monopolies, and the types of direct competition that might rapidly spread this technology. For example, the telephone systems are still basically precluded or discouraged from promoting and integrating cable television, telephone, data exchange, and computing services for households. Whether this regulation prevents formation of inexpensive new services and retards innovation is a debate beyond the scope of this report.

Patent and copyright laws, on the other hand, were reported to us as adequate for the present although far from perfect. It is anticipated, however, that as the new technology becomes more standardized and pervasive and as very high quality software becomes available, it will become increasingly difficult to protect copyrights.

The effects of other federal policies are also much debated in this industry. American tax policy is accused of failing to subsidize research and development as is done in Japan, and this failure is cited as a disincentive to innovation. Antitrust regulation that prevents much cooperative research is also cited. But establishing the validity of these observations is beyond the scope of this effort.

Finally, with regard to federal actions for special groups such as economic subsidy to the disadvantaged and handicapped to obtain new technology, the major observations from industry include the following. The large major producers typically ignore such markets when they are distinct from the general consumer market. The specialty producers that make high technology devices for the handicapped say the government support systems for the handicapped require that each unit be sold twice, first to the handicapped person and then to the agency service worker who holds the purse strings. Thus, federal and state funds are seen as helping this market, but the fragmented and uncoordinated government distribution system for support fragments the market and significantly increases the marketing costs of the firms.

### Characteristics of the New Technology

We found two overriding characteristics about the "new" electronic media, from electronic games and video recorders to instant superstation-CATV national networks. First, this technology offers almost unimaginable leaps in the potential diversity of channels for delivery of information into private homes at rapidly declining prices. In educational terms, this development means tremendous potential to move toward more individualization, and on-demand self-directed access. Producers of both hardware and software will begin to differentiate the market as a means for promoting business success. This situation contrasts with most broadcast media reaching into the home today that has been developed through a strategy of locating the lowest common denominator mass product. Electronic message delivery will soon become as diverse and economical as the diversity of print publishing.

The second characteristic of the new electronic media is the rapid innovation in integrated circuit technology that continues to cut the cost of basic logic and memory components for computers dramatically (by a factor of two each year). Moderate industry estimates are that the six orders of magnitude increase per dollar in computer capability in the last 25 years will be repeated in the next 25 years. This development could mean, literally, that computers costing one million dollars today will be available at calculator prices if there is large volume consumer demand.

These two characteristics--rapid expansion and differentiation of communication channel capability and expansion of computing capability both at rapidly declining costs--make the new home communication and information processing media fundamentally different from the Instructional Television (ITV) and Computer Assisted Instruction (CAI) of the 1960s and early 1970s.

Five distinct types of continuing rapid technological change are interacting to revolutionize information dissemination and to provide information processing in the home:

- (1) Increases in integrated circuit power and decreases in volume production costs.\*

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\* It should be noted that the fixed cost of each integrated circuit is very high while the marginal cost is low. Only in production runs in the hundreds of thousands are ICs economical.

- (2) Increases in video recording techniques (disk and tape) and decreases in volume production costs.
- (3) Improved satellite broadcasting to ever smaller ground stations at decreasing costs.
- (4) Increased penetration of hardwired systems (fiber optics and coaxial cable) into the marketplace.
- (5) Improvements in the science of programming. For example, development of logic circuits (where soft and hardware meet) such as LPC (linear predictive coding) that makes possible the high quality voice synthesis chip from Texas Instruments found in such devices as the "Speak and Spell" and the talking calculator.

Combinations of these technologies added to the communication systems already in society offer at least six types of new media which could be used to augment teaching in the home (and in the school).

- (1) Logic Devices: The microprocessor combined with digital storage systems such as tape recorders and solid-state memory devices make it possible to perform information processing very cheaply in the home as well as at a communication system head end such as a cable television central office. This situation is leading to a rapid development of logic devices for the home, ranging from calculators and electronic games to home computers. The home computers can work independently or be linked to remote systems by telephone, cable systems, over the air broadcasting or cartridges that can be purchased over the counter or mailed. Such systems will introduce the first truly sophisticated artificial intelligence devices and intelligence augmentation devices into the home.
- (2) Recording Devices: The science of video and audio recording has generated a variety of new devices such as video tape recorders (VTRs), video disk players, and read only memory chips (ROMs). Such recording and playback systems offer the home-user a major increase in control over the scheduling and content of material to watch or hear. The video recorder in particular offers the potential user the ability to watch sequentially two programs that are being broadcast simultaneously and to watch at a more convenient time programs broadcast at unusual hours or at a time when the user cannot watch.
- (3) Over-the-Air Broadcasting: In terms of providing immediate impact on the home of most Americans, the current changes in over-the-air broadcasting could revolutionize home viewing and information access most easily because most homes already have television sets. Subscription broadcast television will allow users to buy what they most want to see. Improvements in satellite transmission systems make it possible to disseminate signals economically to remote CATV and UHF broadcasters creating instant new national networks based on a "superstation." Further changes in satellite technology have made direct satellite-to-home

transmission technically feasible with a two-foot home antenna dish costing about 2 thousand dollars. This dish will become much more economically viable in the next few years. With several different antennae each pointed at a different geostationary satellite or with one movable dish, the number of channels that could be broadcast to the home is practically unlimited (that is, 24 channels per satellite with today's technology, and this number may soon go to 48). Whether this type of broadcasting will be allowed politically is quite another matter.

- (4) **Hardwired Broadcasting:** The relaxation of FCC restrictions on cable distributors and extensions to the phone systems of a right to compete in the cable industry may lead to a major increase in the penetration of cable systems into American homes. Today nearly 20% of American households have CATV connections, and cable trunk lines pass within easy direct hook-up distance of 30% more. Equally important, although more remote in time, is the shift in telephone trunkline technology from electrical to light transmission and from analog to digital information exchange. This revolution in the telephone system will have even greater impact than cable systems because it will make possible very inexpensive point-to-point data transmission to and from the home (for example, the children in Los Angeles can send a two hundred word letter to grandmother in New York for a nickel and have instantaneous delivery).
- (5) **Two-way Integrated Systems:** Combinations of the technologies just discussed will permit two-way communication systems with complex information processing and programming at both ends. The "Qube" two-way cable television system is a hardwired experiment in this technology. The ITFS (Instructional Television Fixed Service) systems of various universities and parochial schools are experiments in two-way systems using over-the-air broadcasting with video outbound and voice/data return.
- (6) **Accessory Devices:** The same technology that is making possible these communication media is also supporting the development of accessory devices that make the media more easily accessible or powerful. Such devices range from special items such as paper tape writers to allow the nonoral to communicate, to remote control devices of all kinds, to robotics. The accessory device that is at least a decade away but highly sought after by business is the voice-to-machine code translator. Such a device would allow anyone to communicate with a computer simply by talking to it.

All these technologies are already beginning to penetrate the social fabric. The rate of penetration is very unpredictable, depending in part on the relative costs of the technologies but, more importantly, on whether or not systems that can or should be built should be restricted by existing legislation, regulation, and vested interests.

## In-Home Educational Technology Trends

We have sorted the trends identified for us into four areas: trends in the physical hardware systems; trends in the software content; trends in distribution and media access; and trends in the integration of new technology with existing social institutions and lifestyles.

### Trends in Hardware

The new electronic hardware is being designed to meet two basic demands: general consumer demand for entertainment, and public and private business demand for better communication, data processing, and artificial intelligence. Education considerations are not a major force on hardware producers. It is not clear what should be taught or how, because manufacturers also fear lawsuits from claiming educational or therapeutic benefits for their products unless there is an independent test and certification program, and because the potential user public is not organized to make its educational wants known.\* Hence, the hardware systems are being designed without much attention to potential education applications. This inattention is compounded for the poor, low motivated and handicapped because they lack political and economic power. Basically, manufacturers lack leadership direction, and motivation to focus their educational interest and to cause education to be included in their system design planning.

On the other hand, with one exception,\*\* the basic technology breakthroughs have been made to open up a generation of product development that could result in inexpensive hardware systems to perform in the home nearly every conceivably desirable information transmission and processing function. Because this domain of products is in the development and early growth stage and because it will be years before there is anything close to market saturation, business is focusing on those segments of the market with the most clearly defined need and the greatest willingness and capability to buy.

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\* We are not saying that manufacturers do not see or pursue a large education market. One major manufacturer expects its educational device and software cartridge market to top \$80 million in 1981. However, this market is less than five percent of its total sales that are primarily in the entertainment and business areas. This education market will largely depend on consumer purchase of home computers for other entertainment and business purposes.

\*\* The one exception is direct translation of human speech into machine code. However, the commercial value of this breakthrough is so great that it is receiving strong attention and need not be of concern to HEW at this time to encourage its development. A future role for HEW (probably in the 1990s) may be to encourage a simple, less expensive version of such devices once the basic technology is well developed.

With middle-class populations in mind, a broad array of devices are emerging with potential applications to in-home education. These include:

- o Solid-state, home color television cameras (once commonly available in homes, these cameras may make TV telephone economically feasible).
- o Increasingly sophisticated electronic games.
- o A wide range of drill and practice devices for basic skills.
- o Language translators.
- o A wide variety of electronic control devices.
- o The Kurzweil reader and opticon (that allow the blind to read printed material).

Much of this technology is not "new" but is now being produced at costs inexpensive enough to reach major consumer markets.

New devices currently in development but not yet widely marketed to consumers include:

- o Portable computers that are fully self-contained.
- o Very large-scale inexpensive random access memory of both read only and read and write types.
- o Very large-scale inexpensive logic chips.
- o Human speech-to-machine code translators.
- o All sorts of robotics.

In addition to the preceding devices, which can be used independently, many new devices are being developed to link components into more powerful systems.\* Examples of such devices are:

- o Portable computer terminals.
- o Point-to-point facsimile delivery.
- o Electronic data transmission systems (for example, electronic mail).
- o Cable television systems with such options as "pay" television and interactive television.
- o Satellite to small-ground station transmission.
- o Subscription broadcasting.
- o "Superstations."
- o Video conferencing.

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\* These systems are technologically feasible. Whether they will emerge depends largely on how they and other communication systems are regulated.

- o Teletext and viewdata.
- o Remote CAI or CMI.
- o Caption television.

New devices expected by industry in this category in the near future are:

- o Full two-way human voice-to-machine code communication.
- o "Light pipes" or fiber optics.
- o High-speed dialing/data exchange in the phone system (for example, the five second or less long-distance phone call, also called "packet switching").

### Trends in Software

Two major changes in the underlying pressures on software design are significantly affecting the philosophy of software design. The first of these changes is the proliferation of communication channels and the increased opportunity for consumers to be selective in choosing their media fare. This change is expected to lead to the same sort of market segmentation and targeting that has become true of the magazine industry. The second pressure is the rapid decline in computing and data storage costs. Throughout the 1960s and most of the 1970s, these costs were relatively high and software, particularly educational software, was designed to conserve computing and data storage as much as possible. Computer costs are no longer high and are expected to continue to decline until they are as negligible as the cost of ink and paper in publishing.

Software system characteristics are currently determined by two of the same basic set of forces driving hardware:

- o Public demand for entertainment.
- o Public and business demand for better communication and data processing and artificial intelligence.

However, there is a third force (or lack of one) at work here. The new media is not well understood. What will sell in the marketplace is not well-known, even in the entertainment area. "Speak and Spell" sold well last year but it is unclear whether the novelty of the toy or the "spelling" content sold the device.

In addition to this limitation, producing software for the new media requires technical skills and modes of thinking that only a small fraction of the population has. Variety and depth of software for the new media awaits the development of media literacy in the new media comparable to or greater than the print literacy of the nation.

Software development is currently being held back by a shortage of people with the knowledge and skill to use the media, with the skill to identify and incorporate human learning needs and styles into the software, and with the expertise to do detailed market analysis for the new software.

The trends in this type of recorded software are basically two. One trend is toward developing highly varied, focused market products, just as the magazine industry has done. This market ranges from popular movies and sports events to pornography. The second trend is toward exploring the price elasticity of the market. Only in the over-the-counter market can the intensity of consumer demand for video material be fully tested, and industry wants to establish this market. Advertisers currently pay approximately 10 cents per hour per household for prime time viewers. Consumers have already demonstrated they are willing to pay much more for an hour of video entertainment when they can choose what they want to see when they want to see it.

The trend toward rapid development of over-the-counter software is being affected by several key factors. First, the backlog of material ready to be packaged and sold in this form is limited. Unlike books, our national library of film and video material has been growing for only 20 to 60 years and is very limited. Much of it is dated and unsuitable to today's markets. Second, the video players are not standardized so that alternative recording cassettes and disks must all be available in the same market area. Third, because of these first two items that limit the variety of available software, there is still limited incentive for consumers to buy video players.

The industry contacts in this survey expect the most radical changes in software available to the home in the next five years to come in the areas that are delivered electronically. The first change will be a proliferation of television channels specializing in themes such as 24-hour news, old western films, first-run movies, and sports. The second major change will be an increase in direct per-program purchase of broadcasts by subscribers. The third change will be the gradual introduction of interactive video software. Some of this interaction will be audience participation programming and some will be interactive information services. In any event, the trend will be away from homogeneous network competitive scheduling and toward market segmentation and product differentiation.

The single most exciting trend in this whole arena of new media is the increasing incorporation of artificial intelligence and judgment into the information machines. By incorporating complex logic circuits into ICs, combining them with very large memory systems and sophisticated programming software, we are beginning to incorporate true instructional behavior into machines. The trend in basic logic of computing software is moving therefore, away from presentation of lock-step, predigested material toward simulation-based learning.

#### Trends in Distribution and Access

No segment of American household activity is more extensively regulated than its communication activity. The mail system, telephone, radio, television, CATV, even the book, newspaper, and recording industries operate under a pervasive and complex set of regulations "in the public interest." As a result the technical channel capacity and flexibility of the communication media existing now has hardly been tapped. Recently,

however, this industry has had some deregulation by the FCC, and a major change in legislation is proposed that may change the situation by the mid-1980s. The new electronic media are creating havoc in this artificially controlled communication world. Electronic mail may replace most long distance traffic in the postal system. VTRs may destroy the network strategies of competitive scheduling. The telephone systems could provide cheap two-way interactive exchange between individual homes and a wide variety of "head ends" but is specifically precluded from doing so.

The tremendous profits to be made in communications industries (hundreds of billions of dollars) have caused a large entrenched system of legal and political institutions to draw up defense lines around much of the current market structure. It is very likely that little of the technical flexibility available in the hardware will be allowed or encouraged to "flower" because of these very powerful economic and political lobbies. We may be well into the 1990s before the systems of delivering signals to homes are allowed any significant change. Nevertheless, even though change may come slowly, the variety of new systems is great and could permit a much greater opportunity for all of us to contribute to the system as well as make our special needs known in a way that can be uniquely served.

The issues in improving quality and equity of distribution of access to the new media fall into two basic areas: issues relating to access to the new electronic products and software, and issues relating to being a producer or otherwise influencing the content and structure of the new media.

General issues of access to new electronic products and software include the following. For the general population, the organization infrastructures necessary to identify and respond to consumer demand are only beginning to emerge. For special groups such as the poor, the new devices and software cartridges are often expensive, thereby excluding them. Poor neighborhoods are not attractive to system distributors and hence will get cable systems later, if at all. To the extent that pay and subscription television do penetrate the homes of the poor or handicapped, such people may still not be able to pay the necessary price, or their wants may not be sufficiently intense in terms of their willingness and ability to pay to get the kinds of output they want. The new media can be sensitive to intensity of demand but will be only if the poor can show their interest with dollars or political clout.

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\* For example, each of the hardware units described in this report could be made available most cheaply in the household of the 1990s if they were combined into an integrated system. However, the political, economic and antitrust practices now prevailing will probably prevent such an option from becoming reality. It is highly unlikely that one firm will be allowed to provide integrated telephone, cable television, point-to-point data transmission, and computer support for the home even though the economic logic is behind a natural monopoly to put one hardwired connection into each home.

But not all the problems are economic or proprietary. One key feature of education in our society is that we certify learning with course credits, grades, and diplomas. There is little or no infrastructure to "give credit" for home learning using the new media, and no infrastructure to certify the learning content of an electronic media presentation.

Other issues limiting access include:

- o Local government decisions to delay installation of distribution systems, especially CATV systems.
- o Federal restrictions on the latitude of subscription and pay television broadcasters as to what materials may be shown when in order to prevent "siphoning" of popular programs from commercial television.
- o Restrictions on the phone system acting as a common carrier and billing mechanism.

General issues of access to being a producer or otherwise influencing the content and structure of new media are even more complex. The first issue is the general lack of media literacy (other than print literacy) in our society. Very few of us have any training in the technical skills of video production or computer programming and even fewer have any training in media appreciation that would be analogous to our training in literary criticism or art appreciation. More effort is typically spent in schools teaching children to appreciate and critique live drama than is spent on video or film appreciation. As a result, very few of us are literate in this new media and able to be independent producers.

For the poor and handicapped, this problem is even further compounded by the lack of both the economic and political clout to ensure that their needs are met. For example, there is very little sensitivity in the media to provide realistic role models for the poor and even less for the handicapped in today's commercial video and film industry.

Other impediments to the public influencing what goes into new media content or the structure of its delivery include:

- o A lack of an infrastructure to represent consumer interests and provide protection but, more importantly, to represent consumer needs of special groups.
- o The union-industry structure that, combined with the high skills needed and high capital costs, make it difficult to start new small firms in this industry.
- o The natural monopolies that still exist in the broadcast television and cable television industries.

## Trends in Integrating New Technology into Career and Home

The most elusive and yet the most important trend that will affect the development of new in-home educational systems is the rate at which this new technology is integrated into the daily life of the general public.

The impact of the new media could create social trauma in the next several decades comparable to that of the industrial revolution of the last century. The principle impact will be on the nature of jobs and employment and the less skilled, less well-motivated, and those already on the low fringes of new media literacy will be put at great new disadvantage. Meeting the education needs of these populations will be critical to avoiding the sort of bifurcation between "haves" and "have nots" that could result from replacing the semiskilled and moderately skilled laborers with new technology. On the one hand, robotics with artificial intelligence will increasingly replace unskilled and semiskilled factory workers. On the other hand, the new media will create opportunities for a growing workforce of information workers.

Thus, while the new electronic media will create many diverse opportunities, that fact in itself may be the greatest threat it poses to the poor and low motivated students and handicapped. Both these populations share as one of their most severe problems the inability to extract the benefits available in these new tools and opportunities at a rate that allows them to keep up with the rest of society. "Sesame Street," for example, has been shown on the average to help upper- and middle-class children as much if not more than poor and low motivated children. Such evidence indicates that no hardware/software package should be expected to do much to eliminate the educational disadvantages of these groups. Changes in the social support system to deliver and encourage the appropriate use of new and old hardware and software will provide the only reasonably likely solution. Without providing the motivation and linkage of the content of the new media to real life and career improvement possibilities for these populations, the potential positive effect will be minimal. This situation implies that the major need HEW may want to focus on is establishing the educational program necessary to teach special populations how to learn from and use these new social systems. They must come to expect, and demand of themselves and of the new media to improve their conditions and control of their own quality of life.

At present, remedial assistance to use the new media exists to provide some of the poor and disabled with capabilities the rest of the population have and take for granted. This assistance includes providing devices to permit the blind to read print, the deaf to watch captioned television, and similar devices. However, there is no trend we could detect toward developing the sorts of career planning and lifestyle adjustment programs to prepare for the changes the new technology will cause in lifestyle opportunities for these populations.

### Gaps In New Technology Trends To Meet In-Home Educational Needs

Based on the preceding discussion, we conclude that in the area of hardware very little action is needed to encourage industry to produce high quality flexible technology for in-home use at moderate prices. With the exception of meeting the needs of very small specialty markets among the handicapped, desirable hardware will be produced without government help. Even the hardware standardization issues will be resolved because these issues are in the industry's own best self-interest.

However, four areas of major need are not being met by industry today:

- (1) Because the education market is of marginal value, for the reasons stated above, industry is not investing the tens of millions of dollars needed in basic research and courseware development to identify the form, content and style of new software technologies appropriate to providing in-home instruction through electronic technology.
- (2) Industry is not pursuing as a major objective strategies which guarantee that social applications of the new technology are equitably accessible, especially to the poor. To the contrary, industry is focusing on the affluent business and middle-class market needs almost exclusively.
- (3) Industry is proceeding without any leadership or guidance relative to educational, health, and social welfare applications of this technology except for that guidance provided by the marketplace. No clear and coordinating set of federal or state policies exists to provide social goals for the new technology. Current regulations and many new regulations under consideration are not being planned and analyzed carefully for their impact on encouraging educational and other social benefits or for their impact on protecting and improving the quality of life of all citizens.
- (4) Industry trends in development of software and courseware, as well as trends in public and private sector management for this technology, are limited by the capability of today's higher education to produce, in number and quality, trained young professionals with needed "know how."

## BIBLIOGRAPHY

- "British May Use Telephone, T.V.s to Tap Data Bank," Science, Vol. 201, July 7, 1978, pp. 33-4.
- Brown, J.S., A. Collins and G. Harris, "Artificial Intelligence and Learning Strategies," in Learning Strategies, Academic Press Inc., 1978.
- Brown, J.S., and R.R. Burton, "Diagnostic Models for Procedural Bugs in Basic Mathematics Skills," Cognitive Science, Vol. 2, 1978, pp. 155-92.
- Communications Outlook: Focusing on Communication Aids and Techniques:  
Vol. 1, No. 1, Spring 1978; Vol. 1, No. 2, Summer 1978.
- "Computers and the Learning Society," Hearings before the Subcommittee on Domestic and International Scientific Planning, Analysis and Cooperation of the Committee on Science and Technology, U.S. House of Representatives, Ninety-Fifth Congress, First Session, October 4-27, 1977.
- Davis, M.D. (Chairman), "To Support the Learner," A Report to the Commissioner of Education from the Task Force on Educational Technology, 1979.
- Directory of National Information Sources on Handicapped Conditions and Related Services, Clearing House on the Handicapped, Office of Handicapped Individuals, DHEW, 1978.
- Educational Technology: A Second Chance for Instructional Television, Special Issue, May 1976.
- Educational Technology: Close Encounters with Lifelong Learning, Postsecondary Education Covering Authority, Monthly Dialogue on Lifelong Learning, May 22, 1978 (Interviews with D.F. Bodwell, S. Fratkin, G.G. Gage, H. Morse).
- "Electronics Helps the Handicapped," Electronic Business, April 1979, pp. 76-80.
- "Evaluation of Markets and Distribution Systems for Video Tape," Client Private Report, SRI International, June 1977.
- Heinrich, R., "Institutional Barriers to the Use of Instructional Technology," unpublished report prepared for the Educational Technology Taskforce, U.S. Office of Education, 1978.
- Howe, A., and Romiszowski, A.J. (Eds.), International Yearbook of Educational and Instructional Technology 1978-79, Nichols Publishing Co., New York, 1978.
- Komoski, P.K., "Barriers to the Effective Use of Educational Technology," unpublished report prepared for the Educational Technology Taskforce, U.S. Office of Education, 1978.

- Lipson, J.I., "Conditions for Progress in Instructional Technology," Computers and Communications: Implications for Education, Academic Press Inc., New York, 1977.
- National Instructional Center for Educational Media: Automated Inventory of Instructional Materials Indexed by Subject and Media Type (accessible through DIALOG).
- New Product Opportunities Relating to Consumer Electronics, Client Private Report, SRI International, December 1976.
- Nilles, J.M., "Opportunities and Threats From the Personal Computer," Futures, April 1979, pp. 172-76.
- Norris, W.C., "Via Technology to a New Era in Education," Phi Delta Kappan, June 1977.
- Public Law 94-309, Sec. 392A: Telecommunications Demonstrations.
- Rothenberg, D., "Education of the Handicapped Child: Status, Trends, and Issues Related to Electronic Delivery," Center for Development Technology, Washington University, Memorandum No. 73/4, December 1973.
- "Senate Beats Van Deerlin to the Draw on 1934 Law," Broadcasting, Vol. 96, No. 12, March 19, 1979.
- Smithsonian Science Information Exchange, Inc.: Automated Inventory of Planned and Ongoing Research and Development Projects (accessible through DIALOG).
- "Superstation Breakthrough," Broadcasting, October 30, 1978, pp. 25-26.
- "The Technician Gap," Larger Focus, May 1979.
- "Technology in Science Education: The Next Ten Years," Report to the Science Education Directorate of the National Science Foundation, draft April 1979
- Walters, I., "Deciding T.V.'s Future," Inquiry, Feb. 5, 1979, pp. 16-20.

### Electronic Technology Firms

(Face to Face Interviews were conducted with staff from the following firms)

Atari  
1265 Borregas Ave.  
Sunnyvale, CA

Control Data Corp.  
8100 34th Ave. S.  
Minneapolis, MN

Fairchild Camera and Instrument Corporation  
464 Ellis  
Mountain View, CA

Telesensory Systems Inc.  
2275 East Bayshore  
Palo Alto, CA

Xerox Research Center  
333 Coyote Hill Rd.  
Palo Alto, CA

### Handicapped Service Organizations

(Face-to-face interviews were conducted with staff in each of these organizations)

Center for Independent Living  
2539 Telegraph Ave.  
Berkeley, CA

Deaf Counselors Advocacy and Referral Agency (DCARA)  
1320 Webster  
Oakland, CA

Sensory Aids  
399 Sherman Ave., Suite 12  
Palo Alto, CA

Rehabilitation Engineering Center  
Stanford Children's Hospital  
Stanford, CA

Appendix C

CURRENT FEDERAL ACTIVITIES RELATED TO  
IN-HOME EDUCATIONAL TECHNOLOGY

## Appendix C

### CURRENT FEDERAL ACTIVITIES RELATED TO IN-HOME EDUCATIONAL TECHNOLOGY

Our study included a brief survey of current federal activities related to the in-home educational opportunities of new electronic media. Six types of activity were explored:

- o Hardware research and development.
- o Development of educational courseware particularly for in-home instruction.
- o Social benefit assessment of applications of this technology.
- o Efforts to guarantee equitable benefit from the technology.
- o Support for training professionals who combine social science, physical science, artistic and public policy skills.
- o Planning and monitoring to support and inform policymaking.

### Fostering Hardware

#### Current Efforts

Several federal agencies, including HEW, are now providing support for the development of new electronic hardware with broad social applications including in-home instruction. For example, the FCC is specifically managing the telephone, broadcasting, and cable systems to encourage low-cost mass audience availability. Life line rates, anti-siphoning requirements, and cable distribution rules assure that a large portion of the population has access to the same physical systems at modest cost. In fact, some rates are set so low that, especially in the case of cable television systems, it is hard to operate at a profit in many geographic areas. In the case of telephones, there is clearly a cross-subsidy of poor and rural infrequent users by the more affluent regular users, particularly business.

Development of and access to hardware for the handicapped is being provided particularly by BEH, and RSA within HEW and by several branches of the VA. Typical research sponsored by these agencies includes development of the opticon, development of a paper tape writer for the non-oral, and experimentation with various electronic control systems for the orthopedically disabled. NSF is also sponsoring some basic research into hardware for the handicapped.

The federal government is spending tens of millions of dollars on hardware systems for noneducational applications to produce equipment which could also be used for in-home education. The same electronic components sought by FAA for aviation safety, by DoD for national security, by NSF for the sake of basic science, or by NASA for the development of space applications, can be used to produce communication and computing systems for in-home instruction.

### Impressions

HEW is more advanced in its support of hardware than it is in any of the other five activity areas we explored. Most hardware needs are now getting serious government attention. However, a problem arises out of a lack of coordination in government sponsorship of hardware. There is little continuity between programs even within HEW which means that some needs fall in the gaps between agency responsibilities. For example, disabled young adults may be too old to come under the jurisdiction of BEH and yet not be within the jurisdiction of RSA because they are in college and not yet seeking employment.

### Options

Two specific suggestions were made to us for government actions related to hardware: (1) Develop a means to make manufacturers aware of the special design needs of the handicapped so that when new products are designed such needs can be accommodated, particularly when the cost of such accommodation is very low. Manufacturers cited the high cost versus the limited additional market potential typically gained as the reason they do not gather this data themselves today. (2) Conversely, require government agencies sponsoring research on special devices for the handicapped to attempt to make those devices match a large consumer market demand. This would facilitate both economies of volume production and also assure that the product will be easy to obtain and service through widespread distribution and maintenance systems. For example, the deaf need low-cost teletype terminals and computer users need portable computer terminals. Possibly, one terminal could be made to satisfy both needs at the same time at lower cost than producing two distinct units.

### Support for Development of In-Home Courseware

#### Current Efforts

Several agencies are sponsoring development of courseware for telecommunications media. AID and other agencies such as NASA on satellite-related projects in support of AID continue to sponsor the development of educational technology systems for developing countries such as Mexico and Indonesia. This effort declined to some extent as the complexity of the political and cultural as well as the educational problems became evident. However, many developing countries are still interested in using radio and television to solve mass education needs.

GSA maintains a library of audio-visual materials developed by government agencies. These materials are available for use by other agencies or the public.

In the late 1960s and early 1970s, HEW, DoD and NSF all funded significant computer aided instruction (CAI) projects. The largest single continuous effort in CAI is "Plato," being undertaken by Control Data Corporation (CDC) in concert with the University of Illinois. CDC expects this project to continue, with two significant design changes: (1) a shift

to decentralized processing, and (2) a shift away from programmed instruction to simulationbased instruction. The principal sponsor of CAI now seems to be the military.

NSF is continuing to sponsor some small grants on use of new technology in instruction, particularly science instruction.

BEH and RSA and VA are supporting some software development for the handicapped. The main focus of these agencies is primarily on hardware devices and systems such as control devices and devices to offset sense impairment. BEH provides some modest support for using micro-processors to teach English to deaf children and for exploring the use of video games. For example, video games may be useful as therapy devices to develop the coordination that seems to be necessary for children to learn to read.

The only significant federal support for the development of in-home educational courseware for the general population of American children is that being provided for several educational television programs such as "Sesame Street," "The Electric Company," and "Parenting Series." This support is provided under Section 402 of P.L. 93-380 and is managed by the Educational Technology Branch of the Office of Education.

### Impressions

The work being done is dominated by a focus on high quality conventional public television. In terms of the number of people involved and numbers of dollars being spent, very little is being done to research and develop in-home educational courseware that takes advantage of the new technology.

Designing high quality software is a very large and very complex problem. The resources and government attention now allocated to this task are much too limited to deal adequately with it or develop very much of the potential that is there. Remedying this situation will require a significant national commitment to coordinate and expand the currently scattered initiatives.

### Options

Several specific suggestions were made to us for needed government action to promote software:

(1) Develop a funding policy to encourage expanded development and distribution of courseware. One project worth consideration might be a cooperative venture with a private corporation to develop one full-scale education package for home use in one basic skill area; for example, elementary school (K-6) mathematics. The firm could repay the government portion of the investment through a royalty arrangement. Several firms suggested this because of their expectation that such material will be very costly to produce initially and may be difficult to protect from piracy. However, if successful, the social value of the software would clearly be great even if a specific firm could not recover a profit in the marketplace.

(2) Develop ways to certify the educational worth of the learning opportunities in simple self-contained devices, games (such as "Speak and Spell"), and other "instructional" packages for home use, and to suggest ways for parents to improve the educational impact of such items in use. This might be done in cooperation with an industry trade association or a recognized educational testing group. This idea was suggested to us both by specific firms and by several handicapped users. Some minimum certification would allow firms to advertise the educational value of their products without fear of lawsuits and would also help protect consumers from low-quality or ineffective items.

(3) Develop a full range of diagnostic and prescription packages for use by parents in the home to diagnose and direct their child's learning. Such software packages would improve the precision of teaching in the home (or in the school). Parents lack, but are increasingly demanding, ways to determine how well their children are learning and what specifically should be done to help their child. This idea was suggested by our educational consultants and our own research on parent interest in education.

(4) Conduct basic studies on user satisfaction with any in-home instructional device. Such studies would help decide what to teach and how to teach it effectively in the home. This was suggested by firms and the need was confirmed by our education consultants.

(5) Establish community demonstration programs to serve as test and development sites (this might be done by building on existing hardware demonstration efforts). Title II of the Educational Amendments of 1978 encourage such field experimentation.

(6) Integrate the various services, equipment, and material support available to disadvantaged or disabled individuals. The responsibility for integrating the various services and supports of various state and federal agencies now falls on the disabled individual and his or her family. Handicapped interest groups feel that no individual can do this effectively, especially if he or she is hampered by speech, hearing or mental impairment. They suggested assigning one social service worker to each disabled client, to coordinate services. A similar suggestion was to establish a single clearinghouse for information about all in-home educational opportunities and integrate them with personal career and independent living plans.

## Determining and Improving Social Benefits

### Current Efforts

Determining the social benefits and costs inherent in the application of new electronic communication media applied to in-home use is a complex problem. It is not possible to sort out education applications from entertainment, communication, health care, security and other services because the same hardware (the video recorder, the personal computer, or the television set) are usable for all these functions, and the marginal cost of adding a function is small if the physical system permits easy aggregation of users with common needs.

To make a plan for an HEW policy concerning this technology, therefore, a comprehensive study of the full range of social services of this technology should be done. Here we only review the agencies which are most obviously concerned with social benefits which relate to the need for education in the home.

Two types of agency effort were identified. The first are the various studies by the Office of Education, NIE, NSF, and AID on the efficacy to instruction through new media. These include such long-term domestic projects as old Hagerstown instructional television projects, the long-term collection of Dade County, Florida instructional television, and the SUN-UMA (State University of Nebraska-University of Middle America) open university project. In foreign countries social cost benefit and evaluation assessments of instructional radio and television have been conducted from India to Mexico to Indonesia to Great Britain.

However, we discovered no major projects conducting field experiments on the social benefits for education from video recorders and disk players used in the home. No major projects were discovered testing the educational efficacy of microprocessors or personal computers as in-home teachers.

The social benefit studies conducted to date for this new technology are of a much broader and more theoretical nature such as the OTA studies of the social impacts of microprocessors or the large technology assessment of personal computers being conducted currently by the University of Southern California with aid from NSF.

### Impressions

We found no evidence that any coherent and focused assessment of the actual and potential social benefits and costs of the new electronic technology on in-home social services is being made in any depth.

Clearly, various branches of HEW and other agencies are fostering use of new technology in an attempt to improve the quality of life but little is known of how well these efforts are succeeding. For example, BEH and RSA do not have comprehensive field follow-up programs to determine how well their devices serve the intended populations at what costs and complications.

### Options

In the course of gathering data on the topic of assessing and promoting social benefits, some specific suggestions were made to us for needed government action.

(1) Develop a cooperative of industry and public interests to produce career education packages for use by all populations including poor and low motivated students and handicapped. This is an institutions/infrastructure capacity building problem.

(2) Support special population interest groups to develop their own production companies and distribution systems.

(3) Conduct studies of the creation of a national in-home "open university" (possibly based on the SUN-UMA model) in anticipation of direct satellite-to-home broadcasting or today's satellite-to CATV distribution systems.

(4) Encourage federal support for research and development by the nation's telephone companies to serve as the return link in two-way educational broadcasting, especially in rural areas.

(5) Study the relative value of alternative strategies of integrating special populations into part- or full-time jobs using the new technology.

(6) Make the backlog of federally funded educational programming such as "Sesame Street" available to a distributor for video cassette and video disk distribution.

(7) Develop community systems to reinforce use of the new media by families in their homes.

(8) Develop a policy to promote linkage between the new educational media and useful employment, especially for the poor and low motivated.

(9) Develop standardization planning committees for hardware interface standards development. (However, this will not solve the basic volume of production problem necessary to bring down the cost of devices for the handicapped.)

### Efforts to Assure Equity

#### Current Efforts

Our review of current government programs revealed four major efforts to provide broad social services with the new electronic technology and to assure equal access for the poor or disabled.

The first of these is the current set of FCC policies including, in particular, those of the Educational Broadcasting Bureau. The FCC has long attempted to distribute public broadcast programs to the widest possible audience. However, it has been criticized for preventing formation of viable broadcasting systems in low density geographic areas.

To assure broad and equal access to the benefits of new television services and to expand those services in areas of broad "public service," the FCC has attempted to require that multiple channels on cable systems be reserved for education and other public services and even that cablecasters maintain cablecasting production facilities that are available to the general public. These requirements have been struck down by the courts and it is now unclear what public service capabilities such cablecasters must provide or what requirements state and local regulators may place on them.

Second, the Public Broadcasting System is taking advantage of the satellite-to-small-ground-station technology to expand its simultaneous national channel distribution from one to four channels. This will greatly

increase the opportunity to provide programming variety to local PBS affiliates. If combined with an increase in UHF stations, this system could be used to provide multiple simultaneous PBS channels in a given area and thereby serve the less politically and fiscally powerful groups of the community.

Third, RSA and BEH as well as VA are subsidizing the purchase of new technology by low-income handicapped individuals and their families.

Finally, several agencies are developing information services and catalogs (such as RSA's five-year grant to establish a National Rehabilitation Information Center in WDC) and catalogs of available products and services. These should make it possible for the handicapped to determine what new devices and services are available and from what sources.

### Impressions

Government efforts in this area are entirely remedial and not at all preventive. When a new device or capability clearly becomes (or is about to become) available to the general public, the government either attempts to require that it be broadly distributed or seeks a way to subsidize access for the poor and handicapped. We found little evidence of anticipatory planning for these populations even in the technology assessments and long-range social forecasts prepared concerning this new technology. The efforts we found are largely aimed at helping these groups "catch up" through technology along some dimension in which they are already at a disadvantage. We found little effort to anticipate new disadvantages that will arise for such groups from broad social use of the new technology.

### Options

Our interviews generated the following specific suggestions for government action:

(1) Study possible "life-line" or subsidized rates for special populations for information access. Handicapped groups and industry both pointed out that the poor and disabled will often be the last to receive equal service. Without some sort of government subsidy, CATV systems will not be established in some poor urban areas and certainly not in many poor rural areas. Some handicaps such as deafness may justify special rates for information services because of the different burdens handicapped needs place on the system. For example, the deaf need a longer duration connection to complete a long distance phone call but the amount of information they exchange over that connection is much less than a typical conversation.

(2) Develop, or assist private sector development of, a market identification and distribution network for hardware and software to meet the needs of special populations. This also would be helpful to social workers, counselors, and other public and private assistance workers. Industry and special interest groups agree that determining the nature of the need and size of the market is a very significant cost associated with getting the best new technology in service.

(3) Assure that the plausible commercialization plans exist for devices sought for the disabled, poor or low motivated student before significant R&D grants are awarded or require that such plans be produced as one of the first steps in product development. This was repeatedly mentioned by business as the reason why a number of devices developed by government research in universities sit on the shelf. Had a commercialization plan for the device been drawn up before the research was done, the impracticality or unsaleability of the device would have been evident.

(4) Supply to manufacturers clear specifications of the relationship between larger commercial markets and special market needs of the poor, low motivated or handicapped. For example, the blind need optical-to-voice readers to scan books and other printed papers and read the content to them. Business also needs the key component of this product; namely, the scanner that can read print and identify letters and words. This device would automate much document management including such things as mail sorting. Industry contacts continually stressed to us the importance of finding such relationships because only in high volume are most of the new electronic products and components economical.

#### Capacity Building to Train Needed Professionals

We were consistently told by industry and government program staff that three types of professionals are needed. Research professionals are needed who combine the skills of educational psychology with expertise in communication media such as computer programming, film production, and the like. Professionals are in short supply who combine theater skills and teacher expertise to generate artistically appealing instructional packages, especially for video productions. Finally, trained business managers with technical training in some combination of education related social science and the new electronic media are virtually non-existent. We found no agency programs currently sponsoring training of such professionals in any significant numbers.

#### Impressions

In looking for agencies which might be encouraging university support for producing such professionals we found three schools with some emphasis in this area: MIT, University of Illinois, and University of Southern California. While we suspect that there are other universities with some programs to train such professionals, the general situation we found is that most universities clearly separate education, media arts, business management, and the like.

Programs to teach prospective teachers how to use conventional instructional media such as films are generally weak. We found no instance where teachers are required to learn how to teach telecommunication literacy. It is simply not considered an important topic, let alone a basic skill.

### Options

A number of government actions could be taken to help fill the need for appropriate professional training:

(1) Sponsor a program to increase media familiarization and literacy among teachers, administrators, and social service workers. Manufacturers see the lack of media literacy and hardware familiarity as one of the largest single barriers to more use of good instructional media in schools.

(2) Develop materials, loan programs, and education programs in the schools to teach media literacy for home devices to teachers and to make available a library of lendable programs in schools. Both manufacturers and user groups suggested that if students could try out media in the home before buying they could make a better purchase decision, and make better use of the devices subsequently.

(3) Support university research programs into the link between educational psychology and the new media sciences such as computer science and video film production. This was suggested both by manufacturers and by our education consultants as a source of criteria by which the educational effectiveness of new technology could be measured.

### Planning and Monitoring Efforts for Making Policy

#### Current Efforts

Congress is currently considering major revisions in the basic communication legislation which will alter the role of the FCC. Congress has also given HEW (through Sections 206, 207, and 208 of the Amendments to Title II of the Elementary and Secondary Education Act of 1965) a mandate to support parents and institutions in building basic skills capability, especially in the home. Section 207 specifically requires development of television and other technology to contribute to instruction in basic skills. Congress must be the source of the overall commitment necessary to mount a significantly large effort in this topic area.

The Office of Technology Assessment continues to develop assessments and projections of the social implications of various electronic technologies including their impacts on jobs, social mobility and the generality of life. If HEW could coordinate with OTA despite the organizational distance between them in the bureaucracy, future OTA efforts could be an important source of estimates for the broad societal impacts of the technology which will be the content of future in-home education needs.

Agencies such as the FTC, DOC and the Justice Department continue to try to anticipate how shifts in world trade and domestic industrial structure should be monitored to encourage a strong competitive domestic electronics industry.

The only efforts we found that were aimed at broad educational applications of the new technology are those within the Educational Technology Division within HEW. However, this group appears constrained to review

basically only the educational applications of new technology. Because the technology will reach into the home and because education will be a secondary though important social function following such services as entertainment, communication and health care maintenance, the planning and monitoring unit of HEW for this topic must have a broader and more integrated mandate.

### Impressions

The Educational Technology Division in HEW does not have the resources and capacity or the clear mandate to develop the sort of in-depth and long-range monitoring and planning capability necessary in this area.

### Options

Some specific suggestions were made to us for needed government action:

(1) HEW should consider funding research into the likelihood that access to in-home diagnostic and prescriptive packages may shift the power to control education back toward the home. The impact of such changes needs to be examined in order to anticipate the policy changes necessary to encourage appropriate developments and discourage undesirable ones.

(2) Study foreign systems and programs, particularly in Sweden, Holland, Germany, and England which are more advanced than the United States in putting new technology into the hands of the handicapped. Their experiences could speed the process of developing policy in this country.

(3) Investigate the impact of California's new voucher system (if it passes) and other public economic support attached to the child on the relative attractiveness of new technology to private schools or the movement toward parents teaching their children at home outside the public school system.

(4) Conduct a series of social impact studies for policy planning concerning:

- o What educational benefits these new learning systems can provide (especially as they move away from Skinnerian programming toward Piagetian exploration).
- o How children's world view, capabilities, expectations, and sense of control of their own world will be affected.
- o Role of human service worker (third parent) in providing long-range continuity and career planning for their clients from childhood through adulthood.
- o How interactive, active and team learning differ in impact over today's passive individualized learning.

### Summary

Based on this discussion, we conclude that there are four key areas for additional federal action to develop the potential of new technology to provide education in the home.

1. Basic research needs to be supported to identify the forms, content, and style of the new technologies appropriate to serving the whole population while integrating the special needs of special groups least likely to otherwise benefit (such as the disadvantaged, the disabled).

2. Means must be found for managing the development, distribution, accession of social applications of the new technologies that maximizes their total social benefit and minimizes the potentially divisive effects such as inequality of access.

3. Planning and monitoring systems need to be implemented so that in making policy the federal government can respond appropriately to decisions related to the new technologies.

4. Planning and financial support should be provided for capacity building in our university education programs to produce the quality and number of trained young people to develop and manage public service applications of this new technology.